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INSTRUMENTS

INDUSTRIAL — SCIENTIFIC

Devoted to the Instrument Problems of all Industries

Vol. 1 No. 7 Pittsburgh, Pa. July, 1928

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Strength Tests of Telephone Materials.
J. R. TOWNSEND, NEW YORK, N. Y.

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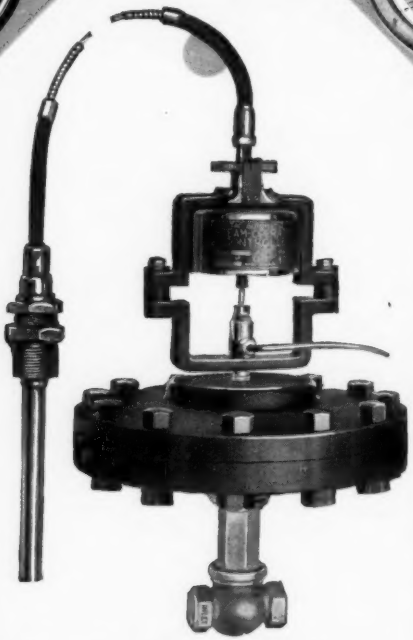

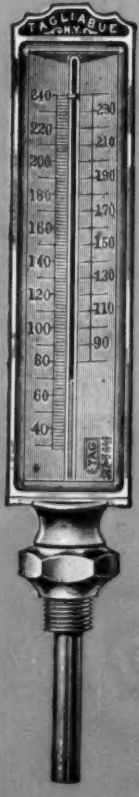

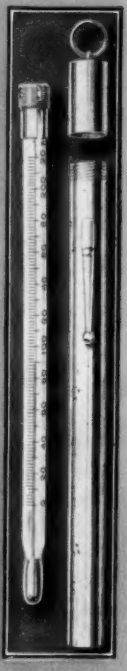

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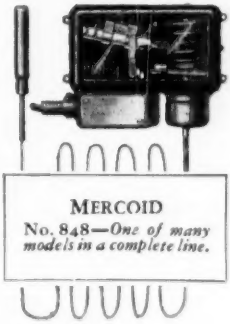

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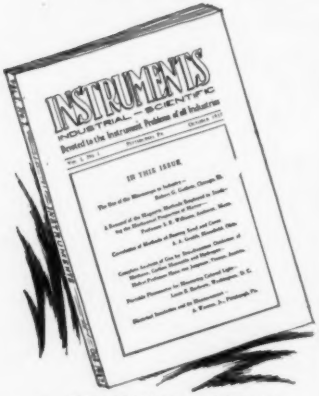

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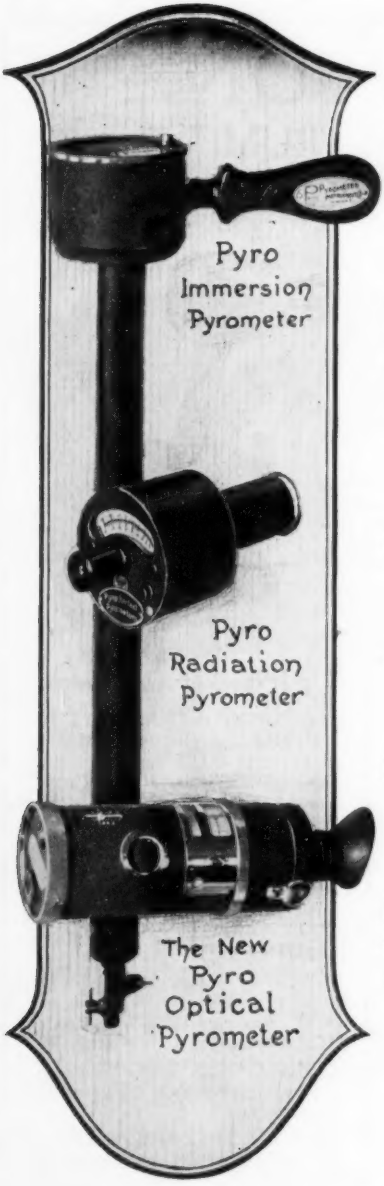

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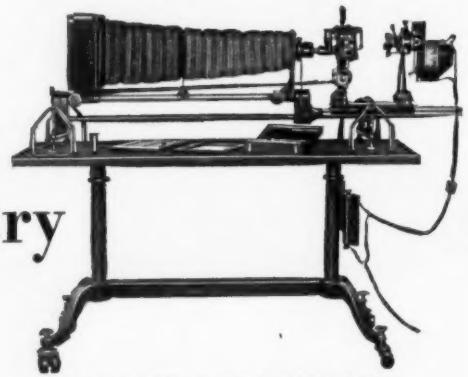

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Published the 15th of each month by

INSTRUMENTS PUBLISHING COMPANY

1117 Wolfendale Street · Pittsburgh, Pa.

George L. Ray, President Richard Rimbach, V. P. & Treas.

Vol. 1. No. 7 PITTSBURGH, PA. July 1928

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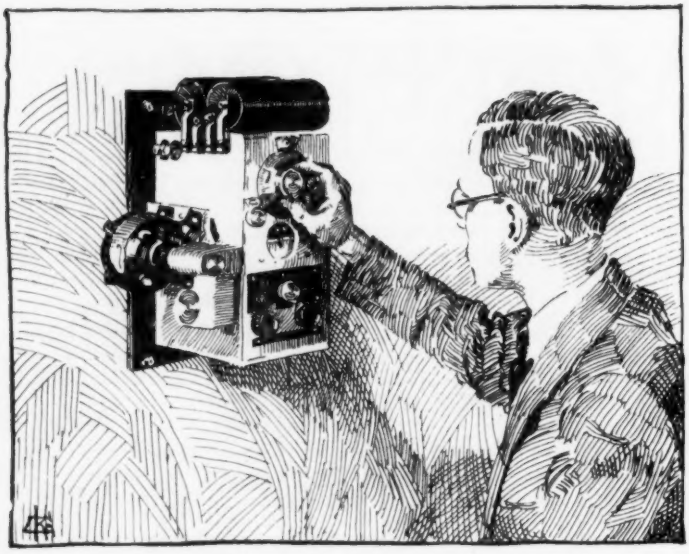

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Vol. 1. No. 7. JULY 1928 Pittsburgh, Pa.

To Our Readers

INSTRUMENTS made its first appearance in January of this year and has even at this early date been recognized as an authoritative source of information on this important field.

The original articles printed to-date have aroused considerable interest. Many additional articles have already been received and these will be printed in early issues of INSTRUMENTS. A large series covering the use and application of all kinds of instruments in science and industry have been promised by men who are authorities on the subject matter covered by their respective articles. The probable titles of these articles are shown in the list headed "Contents of Subsequent Issues."

The editor will be guided in the choice of subjects by the wishes of the readers as expressed on the subscriptions. You will find on the bottom of the subscription blank, in the back of this issue, a list of fifteen items. A number of subscribers have failed to fill in this part of the blank. It is very urgent that this be done as it is of considerable value to the editor in arranging the editorial contents of future issues.

It is also appreciated that as these articles are written by one or two men, that some of the readers may have opinions or information differing from those in the article. If such be the case it will be a pleasure to hear from you. Send your letter to the editor and if the information contained therein appears to be of interest to the readers, it will be printed in the Readers' Comments Section.

The Cooperative Campaign for the Instrument Industry

PUBLIC sentiment campaigns have been conducted cooperatively by various industries to increase the use of the products of those industries. We have seen large scale campaigns by the fruit growers, various groups of lumber interests, cement manufacturers, sheet steel manufacturers, gas manufacturers, power companies, ice companies and the producers and distributers of dairy products.

Probably the most successful and spectacular of these campaigns is the one conducted by the California Fruit Growers Exchange. In 1896, when this organization formed, California shipped about two million boxes of oranges a year and the growers thought they were over-producing. The supply had been so far in excess of the demand that at times the returns were less than the cost. Ten years later the sales had increased

to ten million boxes and twenty years later had passed twenty million boxes a year. As time went on the percentage advertising expense decreased until at present it is less than half what it was at the beginning. It is said that the marketing cost of the California Growers' Exchange is less than that of any other commodity. The success of the Exchange is a striking tribute to the value of organization backed by vigorous persistent advertising.

INSTRUMENTS offers the instrument companies a medium for carrying on a cooperative campaign for the extensive use of instruments in industry.

Trans-Atlantic Flights in the Future

THE importance of instruments for use in long flights is daily being pointed out. Miss Earhart in her story of the flight of the Friendship in the Pittsburgh Post-Gazette stated "Transoceanic flying has to be done by pilots who can fly by instruments alone and I am afraid some accidents which marred past flights have been caused by pilots not too sure of instrument flying." The stories of the Bremen's flight across the Atlantic and of the Southern Cross' Trans-Pacific are now known. The flyers in both cases had to depend upon their instruments. Major Fitzmaurice pointed out that considerable trouble experienced, was due to the erratic behavior of their compass due to the great differences in magnetic variations. He mentioned the very decided advantage to be obtained by the use of a gyro-compass developed for aircraft.

The earth inductor compass depended upon by Lindbergh enabled him to reach the Irish coast at a point only three miles from the planned course. The crew of the Friendship in their recent flight found their magnetic compass worked better than the earth inductor compass. There is no doubt that the difficulties experienced with instruments on flights will be successfully overcome.

Automatic instruments of unerring accuracy may some day relieve the aviator from the never ending concentration upon his compass. A type of automatic steering device similar to that of the ocean liner of today may be used in the airship of tomorrow.

Greater accuracy and dependability are always obtained by automatic instrument control.

Coupon for the New Instrument Section

SO many requests for additional information on the articles in the New Instrument Section have been received on the Buyers' Inquiry Form that a new form has been arranged and placed directly behind this section.

The Buyers' Inquiry Form is intended for requesting information on instruments not listed in the Buyers' Guide. This new form will facilitate matters for the reader.

Appreciation

WE wish to express our sincere thanks to all our readers, who have cooperated with us by sending in the names of their friends and acquaintances, whom they felt would be interested in receiving a sample copy of INSTRUMENTS.

Our Circulation Manager is sorry that he could not acknowledge each one of these letters personally, but found this impossible due to their number.

We again invite every one to send us the names of the people known to them, who would appreciate receiving a sample copy of INSTRUMENTS. These names can be entered on the back of the subscription blank, which can be found in the back of this issue.

——— : : ———

Information in Instruments

A GREAT number of our readers have expressed their approval of our efforts to cover the developments in the field of instruments both in this country and abroad. The editor takes this opportunity to assure these and all other readers, that he will continue to cover by the original articles, new instrument section and current literature review, all information on instruments the world over. A number of very interesting papers have been promised for future issues. NO ONE, WHO IS CONCERNED WITH INSTRUMENTS CAN AFFORD TO MISS A SINGLE COPY.

——— : : ———

Instruments Book Shelf

IN line witth our endeavor to be of the maximum service to all our readers, a new section has been started in this issue. In this section the recent books, on instruments, measuring devices, tests, inspection and control, etc., will be reviewed.

Orders for copies of the books reviewed there, can be sent to INSTRUMENTS BOOK SHELF, c/o INSTRUMENTS PUBLISHING COMPANY, 1117 Wolfendale Street, Pittsburgh, Pa.

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When writing for literature or for information on products or articles which you have seen in INSTRUMENTS, be sure that you give the address as shown in the publication. These addresses are usually keyed. It has been called to our attention that several companies wrote pertaining to instruments appearing in the new instrument section giving an address which was evidently copied from another journal or trade directory. Instruments would have received no credit for these but fortunately, it happened to be the only journal in which this article appeared and we were able to check this through the courtesy of the advertiser.

Contents of Subsequent Issues

Historical Sketches of Men who have contributed to the advancement of the Instrument Science.
The Design of Instrument Transformers.
The Geodetic Level Rod, Its Design and Methods of Construction.
The Measurement of Boiler Combustion Zone Temperatures.
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Mechanical Vibrations and Their Measurement.
Instruments to improve Diesel Engine Efficiency.
Comparison of Instruments for Measuring Hardness.

A Simple Optical Arrangement for Photo-Elastic Experiments

*R. V. Baud, East Pittsburgh, Pa.**

LET a polarized light ray K_1K_2 fall on the reflecting surface of a glass plate, A, (Figs. 1 and 2). Assume first, that this glass plate A is located as shown in Figure 1. The ray K_1K_2 is said to be polarized in the plane $I_1K_1K_2$, when there is no refraction at point K_2, i.e., when the light is reflected in direction K_2I_2 with the original intensity. Assume now, that the glass plate A is in the position shown in Figure 2. This position is obtained from the first one, by rotating the glass plate A through 90° with K_1K_2 as an axis. The reflected ray is now in a plane $I_3K_1K_2$ perpendicular to the plane $I_1K_1K_2$. With this arrangement a lightray, polarized as before, in the plane $I_1K_1K_2$ is completely refracted and damped out by the black glass plate A. Consequently, no light is reflected in the direction K_2I_3. If the glass plate is between these two characteristic positions, part of the light will be refracted and damped out and part will be reflected. Just how much is reflected depends upon the angle through which the glass plate has been rotated (using K_1K_2 as an axis). From this is seen that a black glass plate can be used to determine the plane of polarization of a plane polarized ray. For this reason it will be called the analyzer A.

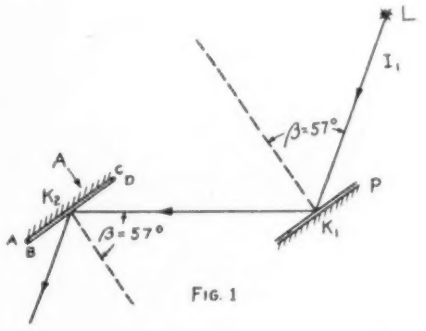

FIG. 1

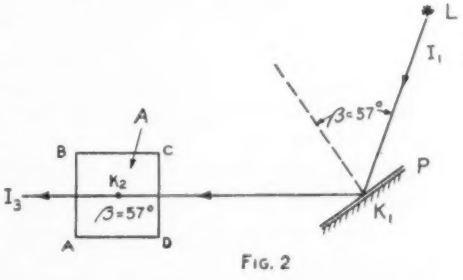

FIG. 2

Let an unpolarized lightray I_1K_1 (Figs. 1 and 2) fall on the reflecting surface of a black glass plate, P. By making the angle β of incidence equal to the polarizing angle (Tan $\beta = n$, where n is the index of refraction), the reflected ray K_1K_2 will be completely polarized. The plane $I_1K_1K_2$ is the plane of polarization. By means of an analyzer, A, we are able to check

*Research Department, Westinghouse Elect. & Mfg. Co.

the correctness of this statement. Any device used to produce polarized light is called a polarizer.

A polarizer, together with an analyzer, forms the basis of photoelastic equipments as ordinarily used. The position of polarizer and analyzer shown in Figure 2 will be further considered. From the above discussion we can see that for such an arrangement of polarizer and analyzer, no light from the lamp L will be reflected in direction K_2I_3.

In Figure 3 the point of intersection (O) of the vertical and horizontal lines represents the line of propagation of the reflected rays (K_1K_2 or K_2I_3). Perpendicular to this direction of travel are the light oscillations. Let the horizontal line, Figure 3, represent the plane of polarization of the ray K_1K_2. According to the theory of Fresnel, the light oscillations are in a plane perpendicular to the plane of polarization. The vector $\overline{OA}$ in Figure 3 represents, therefore, the polarized ray K_1K_2. The vertical line represents plane $K_1K_2I_3$ which is the plane of polarization of the analyzer and the plane of vibration of the ray as it emerges from the analyzer is represented by the horizontal line in Figure 3, because this plane was assumed to be perpendicular to the first one.

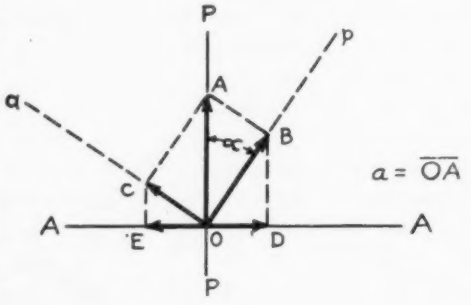

FIG. 3

It was previously stated that this arrangement does not allow light to pass through. This can also be seen from Figure 3. Since the light vector $\overline{OA}$ has no component in the horizontal plane, no light will be reflected by the analyzer.

By introducing a stressed model of transparent material, as one machined from a sheet of celluloid, between polarizer and analyzer in a plane perpendicular to the direction K_1K_2, an entirely different condition is obtained. By viewing the model in the direction I_3K_2 it appears colored, but traced with black bands and spots. The appearance of the colors and the black bands and their practical meaning for experimental solution of problems of elasticity will now be discussed.

The plane polarized ray K_1K_2, represented in Figure 3 by the light vector $\overline{OA}$, is split by the transparent model into two rays $\overline{OB}$ and $\overline{OC}$ in the directions (p & q) of the principal stresses. (Consult textbook of elasticity.) The analyzer reflects only the horizontal components of these rays: namely, the components $\overline{OD}$ and $\overline{OE}$. Since these component light vectors are of equal magnitude (a sin $^{\alpha}$ cos $^{\alpha}$) and have a space phase

of 180° they will produce a combined ray of the magnitude 0, see Figure 4. Therefore, no light at all is reflected and consequently the appearance of colors is not yet explained.

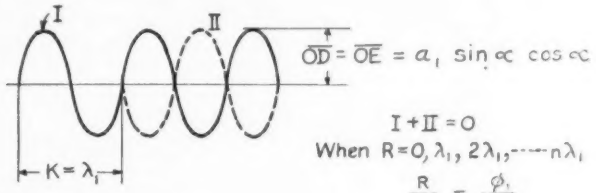
I
II
$\overline{OD} = \overline{OE} = a_1 \sin\alpha \cos\alpha$
$I + II = 0$
When $R = 0, \lambda_1, 2\lambda_1, \cdots n\lambda_1$
$K = \lambda_1$
$\frac{R}{\lambda_1} = \frac{\phi_1}{360}$

FIG. 4

We conclude that something else must occur in the celluloid besides the resolving of the original ray in two component rays. This is true. When passing through the celluloid model, rays $\overline{OB}$ and $\overline{OC}$ suffer a change in wave length depending upon the magnitude of the principal stresses p and q. Since the frequency remains unaltered, there must be a corresponding change in velocity. Consequently, the two rays travel with different velocities through the model and emerge with a difference in time phase, that is, one ray lags behind the other. This lag is a linear function of the difference (p–q) of the principal stresses and the thickness of the model.* As p–q varies at different points on the model, the time phase separation of the components $\overline{OB}$ and $\overline{OC}$ will also vary.

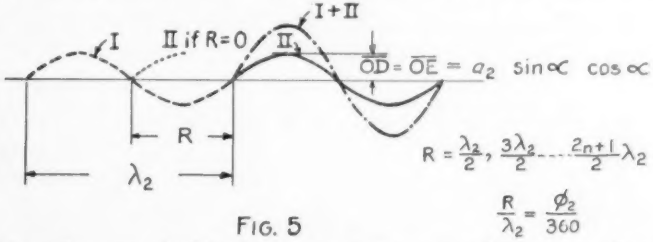

FIG. 5

If it so happens that the lag in time amounts to half a wave length or any odd number of half wave lengths then the lag in time compensates for the lag in space and they add to form a vector of the magnitude 2 a sin α cos α, Figure 5. If, however, the lag amounts to one wave length or any number of wave lengths, the components have the same time phase and are opposite in space phase and, therefore, darkness results, Figure 4. For any value of lag, ϕ, the combined vector will have a magnitude of 2a sin α cos α sin $\phi/2$, Figure 6.

From this discussion it will be seen that by employing white light, instead of monochromatic light, there may be a ray of a certain wavelength $\lambda 2$, which will be reflected by the analyzer with the maximum

*In reality the lag R depends also upon the temperature of the model and the wave length λn. However, as a rule, the variation of R with λn is small in comparison to the range of visible rays and the temperature effect can be neglected in photo-elastic work. In this paper equal lag R is assumed for simplicity. (See also Figures 4 to 6.)

intensity ($4a^2_2 \sin^2 \alpha \cos^2 \alpha$, see Figure 5), whereas there will be other rays with a wave length of λn, for which the super-position of the rays will not give the maximum possible intensity (Figure 6). One ray with

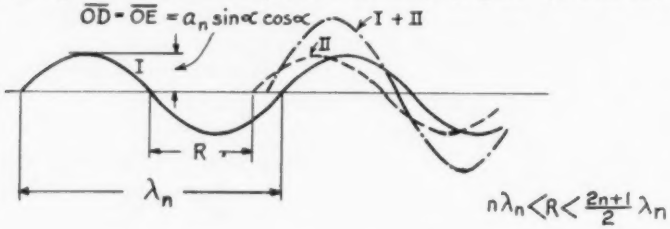

FIG. 6

the wavelength λ_1, for instance, may be damped out completely (Figure 4). We obtain, therefore, a mixture of light rays which, as a rule, will produce a definite color.

From this discussion, we see that the color depends on the lag ϕ and the lag ϕ depends on the stress difference (p–q). In a member of constant section loaded along one axis, the transverse stress q will be zero. Therefore, in this case, the color represents the stresses p directly, see Table 1. This is true also for the free boundaries of any loaded model.

Table 1—Color Scale

Colors produced in a simple tension member machined of 1/4 thick pyralin, manufactured by the DuPont Viscoloid Company.

Color	*Tension in lbs. per sq. inch*	*Color*	*Tension in lbs. per sq. inch*
Black	0	Dark Green	1050–1200
Gray	0–70	Light green	1200–1400
Gray-yellow	70–195	Greenish yellow	1400–1500
Cloudy yellow	195–340	Clear yellow	1500–1630
Yellow	340–500	Orange	1630–1750
Gold yellow	500–700	Brick red	1750–1860
Orange	700–800	Rust red	1860–1940
Brick red	800–900	Brown	1940–2000
Rust red	900–920	Dark green	2000–
Brown	920–1050		

Furthermore, it will be seen that darkness occurs for those spots of the model where p–q. But, darkness is also obtained for spots, where one of the directions of principal stress coincides with the plane of polarization ($\alpha = o$, therefore a $\sin \alpha \cos \alpha = o$). Therefore, the principal stress direction can be found for any point of the loaded model. To find this direction for a certain spot, rotate the model with the direction K_1K_2 as an axis until the spot becomes black. For this position we know that the direction of the principal stress is in the plane of polarization $I_1K_1K_2$,

Figure 2. The black spots, due to the equal magnitude of p and q, are not affected by the rotation of the model.

A polarizing apparatus of this simple type is shown in Figure 7. It consists of two boxes B_1 and B_2 and a frame F for producing external loads in the plane of a model M, which is located perpendicular to the direction K_1K_2.

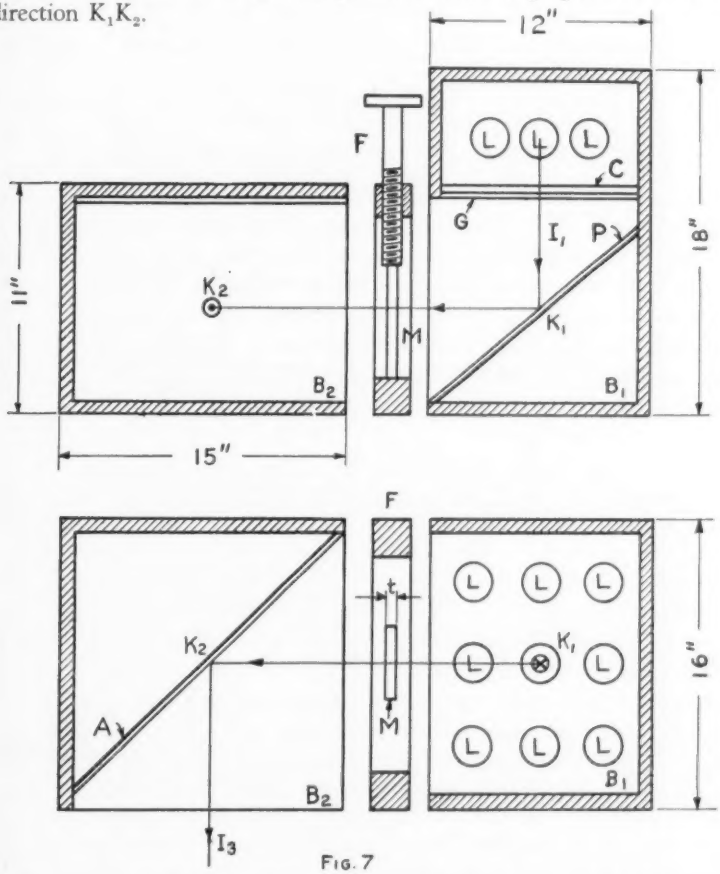

FIG. 7

The source of light consists of ordinary lamps L, placed in the upper part of box B_1. The light of these lamps is diffused by tracing cloth C put on top of the plate of ordinary glass G. Two plates P and A of black glass complete the equipment.

A polarizing instrument of this type was built in the Research Department of the Westinghouse Electric & Mfg. Co., previous to the purchase of the more elaborate Coker instrument. Even this simple outfit offers a useful means for obtaining qualitative information regarding distribution of stresses, and it is suitable for demonstration purposes in industrial work or in engineering schools.

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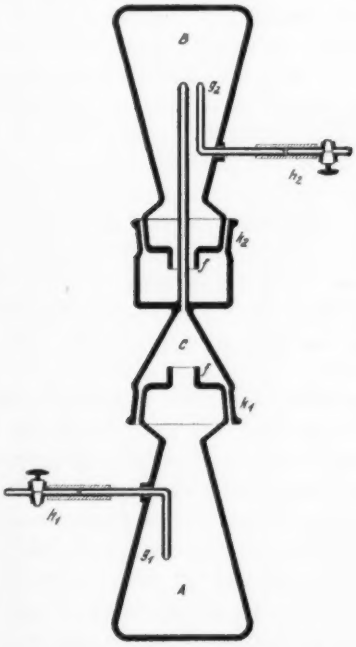
Apparatus for Working With the Exclusion of Air or in a Neutral Atmosphere

*P. Dickens, Ph.D., Duesseldorf, Germany**

WITH the diverse analytical and synthetic experiments one is forced to avoid influencing the investigation by the oxygen, carbon dioxide or moisture content of the air. Many solutions and easily oxidisable precipitates must be protected against oxidation by the oxygen in the air. Other determinations are only then possible if an effect of carbon dioxide of the air is excluded. A large number of solid hygroscopic substances of an organic nature, due to their sensitivity to moisture, must be placed on the filter and washed in the absence of air. Ether extractions of air sensitive bodies must be separated from a drying agent under the same precautions. With other investigations a total absence of air and a working in an inactive gas stream as hydrogen, carbon dioxide or nitrogen is necessary. Often experiments must be carried out with poisonous gases extremely dangerous to health, whereby a completely gas tight sealing of the apparatus is also essential.



In spite of the fact that such investigations must often be carried out, a suitable simple apparatus is lacking. There are several known available for such purposes, but these are not for general use but only for specific applications. In addition they show deficiencies throughout, as for example glass cocks, whose bore is easily stopped up on filtering. A generally applicable apparatus (shown in the illustration), which permits in a simple manner dissolving, precipitating, crystallizing, absorbing, filtering and washing, shut off from the air, in vacuum or in a neutral gas atmosphere, is described below.

The apparatus consists of a solution flask *a* with side tube g_1, which

*Kaiser Wilhelm—Institut fuer Eisenforschung.

can be closed by the cock h_1, a similar flask b as filter flask with a tube g_2 and cock h_2 and the funnel c built in between solution and filtering flask. All three parts are connected by air tight joints k_1 and k_2. The joints are standard, so that all parts are interchangeable with one another. The flasks have a reduction at the upper end f. By means of this extension the height of the liquid layer in the funnel is determined. The solution flask a is connected by means of the side tube g_1, with a syphon flask in which the solution or wash is contained and which can be warmed therein if necessary.

The manner of operating is different, according to the investigation to be carried out. If the investigation is to be carried out with the air excluded or with partial vacuum, the flask is evacuated through the side tube g_2 with the cock h_1 closed. Then one connects the tube g_2 with a syphon flask, which contains the required solution and opens the cock h_1. Due to the vacuum in the apparatus the solution flows into the solution flask, which prevents the liquid rising above the rim of the filter.

If on the other hand the experiment is to be carried out in a neutral gas atmosphere the air is driven from the apparatus, in that the particular gas is forced through the tube g_1, and permitted to flow out of tube g_2. The filling in of the solution is then done under pressure, after one has established a connection with the syphon flask. The filtration then proceeds by a simple reversal of the whole apparatus, whereby in addition to the ordinary filters also colloid filters, glass wool filters or filter crucibles of different kinds can be used. The washing takes place very completely by the built-in nozzle g_1, in that the washing solution, due to the vacuum or pressure effect, is strongly sprayed against the bottom of the flask and runs down the walls.

The apparatus was used* for the determination of silica in carbon and low silicon steels according to the bromine method. Therewith it showed, in addition to its simple manipulation and completed exclusion of air, also its usefulness with experiments with dangerous gases, as trouble with the bromine vapors did not arise. In the same manner the apparatus was used for the production of iron carbide and the determination of carbide carbon, which must be carried out in an atmosphere of carbon dioxide or hydrogen. Several additional possibilities of its use are briefly designated: in inorganic chemistry with the determination of copper, zinc and manganese as sulphide. The precipitates which form are protected against oxidation, as they are continually held in an atmosphere of precipitating medium. On the other hand its use in organic chemistry is manifold; for example with the production of the addition products of cyanogen bromide to tertiary arsines, with the production of triphenylmethyl, with the reduction of indanthren with alkali hydrosulfite, with the production of solid sodium compounds of ketones and aldehydes. In all these cases the cumbersome apparatus set-ups can be replaced by the same convenient handy apparatus.

*P. Bardenheuer and P. Dickens. Mitt. a. d. K. W. Inst. f. Eisenforsch. 9 (1927) pp. 196-207.

Strength-Tests of Telephone Materials

*By J. R. Townsend, New York, N. Y.**

RECENT developments in the mechanical arts have been of necessity away from the ponderous, slow-moving machines of an earlier day toward the concentration of large power in small bulk, with accompanying high unit stresses. Compare the giant alternators of twenty years ago, with their huge triple-expansion engines, to modern turbine generators; visualize the original gasoline engine alongside an airplane motor —one hundred times the power for the same weight. To gain these advantages, newer and stronger materials were developed: we see cast iron replaced, in turn, by wrought iron, steel, and finally alloy steel—each step an enormous advance in strength and durability.

Under the stress of the World War, still further economies had to be effected, and engineers throughout the world reluctantly reduced factors of safety. Then surprising things happened. Machine parts broke in service although they were not stressed to more than half their ultimate strength. Several series of investigations were started: one by the National Research Council, to which the Western Electric Company, among others, contributed. This work was carried on at the University of Illinois; other investigations were made at the United States Naval Experiment Station and by Army engineers at McCook Field.

As a result of these tests our ideas of strength-of-materials have been completely revolutionized. It is now realized that the classical theory treated metals as homogeneous and as having the same properties in every direction. These assumptions are now known to be untrue; for example, modern metallurgical studies show that metals that have undergone certain treatment may be composed of long, narrow crystals which impart to the specimen a rather fibrous structure. Further, no account had been taken of the effect of repeated stresses, in spite of the publication in 1860 by Woehler of a long series of tests. Woehler showed that when stressed again and again, iron and steel will withstand much less than their ultimate (static) strength; that the specimens will hold their strength practically up to final failure, and that they will break with no warning whatever.

As a result of the tests of the last few years, it has been demonstrated that for steel the safe limit for repeated stress is but forty to fifty per cent of the ultimate strength, and for annealed brass it is only thirty per cent. Tests at the Forest Products Laboratory have found definite limits for the wood used in airplanes, at about thirty per cent. A number of investigations have shown that concrete, too, has its limitations:

*Apparatus Development Department, Bell Telephone Laboratories, Inc.

fifty to fifty-five per cent of its ultimate compression strength.

Certain telephonic materials are subjected to repeated stress: cable sheath for example, and contact springs. In the General Apparatus Development Laboratory we are actively engaged in fatigue studies of cable-sheath alloys, and of spring materials. We have learned a great deal about the effects of alloying substances, of heat treatment, of working, of manufacturing defects, and of abuse during adjustment of spring parts.

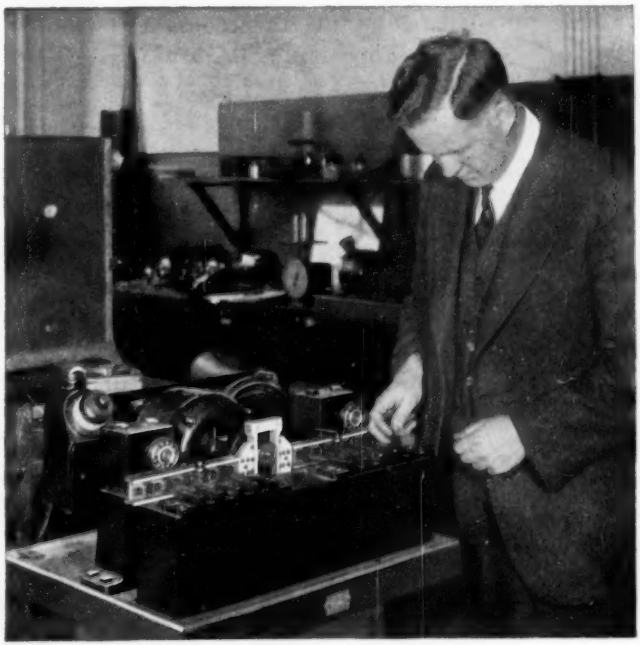
Results of all these investigations have completely revolutionized our ideas of mechanical testing of material. Until recent years, much testing concerned itself mainly with dogmatic procedures where the breaking, twisting and bending strength were determined. Results of static tests on small samples were applied to the design of structures of great size, often subject to dynamic stresses. In the light of our present knowledge, it seems remarkable that these earlier structures were so successful and that disaster was so rare. The answer lies in the generous factors of safety allowed. Nowadays we believe that the elastic limit cannot be taken as a safe basis for design. Rather, the endurance limit should be used, with the static tensile test as a quick inspection test only.

Another property of materials which has received much attention is that of hardness. This may be defined as the resistance of a material to deformation—in particular, to the deformation caused by pressing a small penetrator into the body of the material. This property is tested directly by the Brinell and Rockwell methods and indirectly by the scleroscope. The Brinell test is to force a steel ball into the specimen and measure the diameter of the resulting indentation. This value, and the pressure applied, give a numerical measure of the hardness. The Rockwell test is similar, but on account of its smaller penetrating point and lighter loads it is better adapted to thin sheet metal and to soft metals such as aluminum and lead. The scleroscope measures the rebound of a weight when dropped from a fixed height on the test specimen. This test is not well suited to sheet metals because it is too sensitive to casual variations in the testing instrument itself.

All of these hardness tests are comparative rather than absolute; in some cases their results have been found to correspond closely with the performance of materials in actual service; in other cases they are entirely valueless. Considerable work is being done to associate hardness with other physical properties. Hardness is often considered as an indication of ultimate tensile strength. On the other hand, work done in these laboratories on lead alloys has shown that annealing will effect enormous changes in hardness and practically none in tensile strength.

Since Western Electric Company Hawthorne works makes extensive use of drawing operations on sheet metal, it is important to know the suitability of materials for this work. The Erichsen test is to force the sheet into the form of a cup whose depth before the material cracks is a

measure of ductility. This is a "static" test; its results do not reveal the performance of a material on a punch or forming press at production speeds. A "dynamic" test has therefore been worked out in which the cupping is carried forward at ninety strokes a minute, to simulate factory conditions.



A machine built in the Bell Telephone Laboratories for fatigue tests of sheet spring material.

Impact tests are also made in this laboratory by allowing a pendulum to swing against and break a sample of the material. The pendulum will fail to rise to its free-swinging height by an amount which measures the work done in breaking the sample. This value is useful in comparing molded and cast materials, particularly die castings, as to brittleness.

To keep pace with the exacting requirements as to strength, lightness and cost which are being placed upon materials, there is hardly any form of testing which is not undergoing revision today. In one direction, tests are being simplified and standardized so that they can be used in the inspection of raw materials; in another direction new tests are being designed to reproduce under controlled conditions the stresses which materials will meet in actual service. Both paths converge at the goal of better and more dependable materials.

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Ground Testing**

*T. B. Whitson, Philadelphia, Pa.**

DEFINITION of a "ground." According to the U. S. Bureau of Standards, a ground connection—sometimes termed "ground" or "permanent ground"—is an electrical connection intentionally made between electrical circuits, or conducting bodies in close proximity to electrical circuits, and metallic bodies embedded in the earth, such as water pipes, plates or driven pipes. As the earth itself is considered to be a conductor of negligible resistance, we may arbitrarily consider a "ground" to be an electrical connection intentionally made with the earth. Now, it is seldom possible to obtain negligible resistance between a ground connection and the earth, so we are very much interested in how good a contact a given ground connection has made with the earth. It is the testing of these resistances with which we are concerned and the subject must not be confused with an unintentional "ground" occurring on a line or in a machine, due to failure of the insulation.

It is common practice to "ground" as thoroughly as possible all non-current carrying equipment, such as transformer cases, machine frames, etc., at generating stations and sub-stations. This is done in various ways —by burying plates or masses of metal in the earth, by connecting to metallic building structures and by driving pipes and rods into the earth, and even by sinking wells. It is of great importance also to install adequate grounds in connection with lightning arresters; it being felt by many that the proper functioning of the lightning arrester bears very close relation to the character of the ground connections to which it is attached.

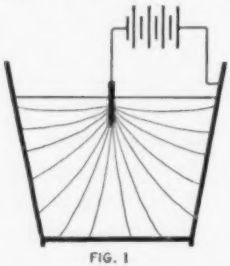
Testing the resistance to earth of ground connections and a consideration of the electrical characteristics of earth are so entirely different from testing the resistance of a coil of wire or determining what goes on electrically in a machine, for example, that it is a bit difficult to find an analogy which will make the subject entirely clear. If you have a metal bucket (Fig. 1) containing salt water, to which one side of an electrical circuit is attached and then stick the other wire into the water, there will be a flow of current through the water in all directions to the sides of the bucket. The current takes an infinite number of paths. Now, suppose we have a porcelain container (Fig. 2) filled with salt water and place the two electrodes a short distance into the water and several inches apart. Current will flow through the water and of course will have the greatest density in the water along a rather broad path directly between the two electrodes. You will find, however, that the current actually is distributing itself from each electrode out in all directions but that the

**A lecture given before the Meter Course at the Carnegie Institute of Technology.

*James G. Biddle.

current paths bend around and come back to the other electrode as quickly as they can.

Possibly you will remember the school experiment of plotting equipotential lines on a surface, or how iron filings arrange themselves in a magnetic field. This diagram (Fig. 3) shows the lines in which the iron



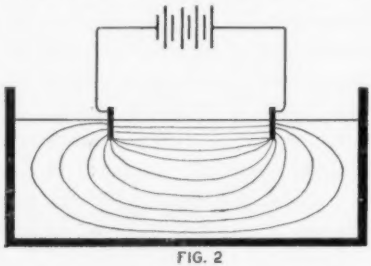


Fig. 1. Showing how current is distributed through a solution of salt water in a metal container.

Fig. 2. Showing how current is distributed between two electrodes immersed in a salt solution in a porcelain container.

filings arrange themselves and is similar to the current paths flowing in the water in the porcelain container—that is, if you consider any given cross section of the water between the two electrodes. In other words, if

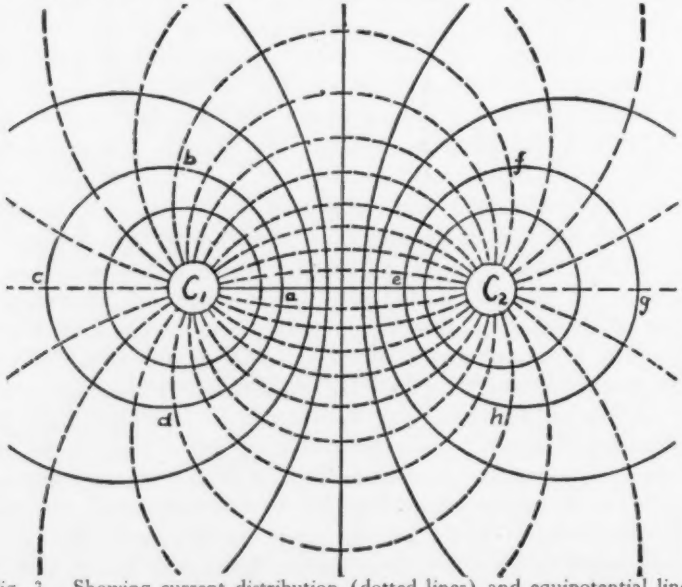


Fig. 3. Showing current distribution (dotted lines) and equipotential lines (full lines) over a surface between two electrodes N and S. This illustrates what takes place, in principle, between two electrodes in the earth. If the dotted lines are revolved around N-S as an axis, we have shells which, in the earth, may be pictured as shells of earth which carry the current.

you take this picture and revolve these lines around the axis N-S, the dotted lines then become surfaces—if you like—over which the current flows.

This is exactly what happens, in principle, when you bury two spheres in the earth and create an electrical circuit between them, and the same thing applies, of course, in principle, to rods or pipes driven into the earth.

Now to get back to our consideration of the resistance to the earth of one of these electrodes. If you measure the current flowing—let us say—into the earth at A and out of the earth at B, and at the same time measure the voltage drop between A and B, and figure the resistance $R = E/I$, this resistance will be the *sum* of the ground connections *in series*, and we have no assurance whatever that they are both equal. Our problem is to find out what *one* of them measures separately. If the two electrodes are far enough apart, the resistance which you obtain is the sum of the resistance to earth of A plus the resistance to earth of B, *and has nothing to do with the resistance of the earth itself between A and B.* This may sound strange, and it is a bit difficult to understand at first sight. The reason is, that the earth is so tremendously large that after you get away a suitable distance from the electrode or ground connection, there is so much earth and of such large cross section, and hence so many paths for the current, that the total resistance in the earth becomes practically zero. We are assuming of course, that the earth is homogeneous and not broken up in complicated strata formations, which, incidentally introduce exceedingly interesting factors into the subject.

Another way to picture the electrical characteristics of a ground connection is to push your pencil into a pot of molasses, and as you draw it out you will notice that a cone of the sticky stuff follows the pencil. This may be called the cone of contact and you will see that as soon as you get away an inch or so, the molasses is undisturbed. Similarly it has been found that the resistance to earth of a ground connection consists of the resistance of the first few layers of earth surrounding an electrode, and as soon as you get away a few feet, the additional layers of earth are so large that the resistance becomes smaller and smaller. The Bureau of Standards has stated that within 10 feet from rods or pipes driven into the earth, you have covered 90 per cent of the resistance. We find, from very careful tests, that to bridge *all* of the resistance one must get out 25 or 50 feet. In other words, the "cone of contact" in the earth is something like 50 to 100 feet in diameter.

A rod or pipe driven into the earth, or any ground connection, has three electrical characteristics:

(A) Resistance to the earth.

(B) Capacity to dissipate energy into the earth—which is a function of the exposed area.

(C) The potential gradient in the earth surrounding the ground connection.

To test the capacity of a ground, requires loading it up with sufficient power to approximate conditions which the ground connection might be called upon to carry. A potential gradient test can be carried out relatively simply, by current and voltmeter methods. The *resistance* of a ground connection is more difficult to measure, but can be accomplished in a number of ways which I want to describe to you; and I shall attempt to point out the advantages and disadvantages of the various methods that are now in use.

Methods of Testing Grounds:

Methods of testing resistance to earth of ground connections may be grouped somewhat as follows:

Direct-Reference Method
- By voltmeter-ammeter
- By Wheatstone Bridge
- By ohmmeter (Fall or Potential)

Three-Point Method
- By voltmeter-ammeter
- By Wheatstone Bridge

Fall of Potential Method
- By voltmeter-ammeter
- By "Megger" Ground Tester

Practices vary among power companies. Some do not test grounds at all, others use elaborate means, go to considerable expense, and make a periodic survey at least once a year of all ground connections on their systems.

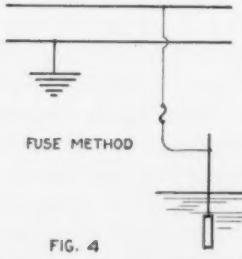


FIG. 4

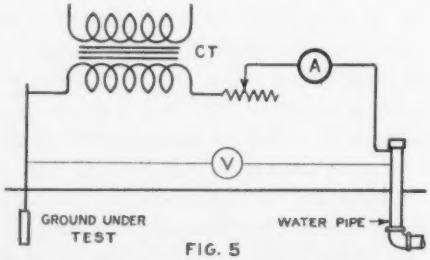


FIG. 5

Fig. 4. The fuse method of testing a ground connection. A fuse of specified capacity is placed in the circuit and if it blows, the ground is considered satisfactory.

Fig. 5. Direct reference voltmeter-ammeter method, using alternating current. Assuming that the resistance to earth of the water pipe is zero, the resistance of the ground under test R is equal to E/I.

Probably the most elementary method of testing a ground connection is to pass current into it through a fuse (Fig. 4) of specified current capacity. The blowing of the fuse—if it does blow—is an indication that

the ground connection is fairly good, but of course, there is no *measurement* involved, and one has very little data of engineering value.

Direct Reference Method:

In the direct reference method for testing grounds it is necessary to have a ground of known low resistance to refer to, such as a water system or other well grounded structure. Under these conditions tests can be made by an A.C. Voltmeter and Ammeter, A.C. Wheatstone Bridge, or, in principle, by direct-reading Ohmmeter. If direct-current is used, serious errors will be introduced on account of polarization around electrodes and stray current in the earth.

The A.C. Voltmeter-Ammeter method requires a source of alternating current, an insulating transformer (unless an underground circuit is available), suitable rheostats and ammeters and voltmeters of various ranges to accommodate grounds of various resistances (see Fig 5). Also the result must be calculated from $R = E/I$. The result is not necessarily the resistance to earth of the ground connection, but it is actually the net

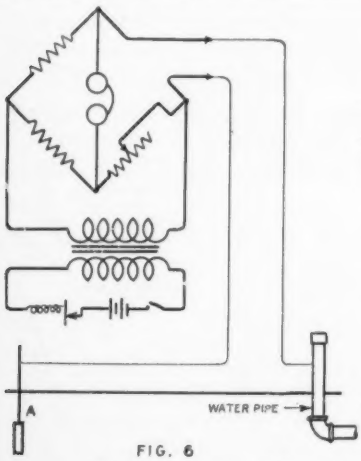


FIG. 6

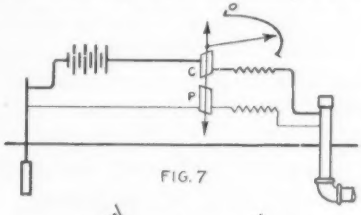


FIG. 7

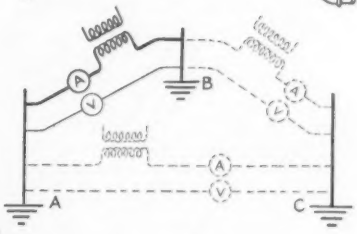


FIG. 8

Fig. 6. Direct reference Wheatstone-Bridge method using a buzzer and transformer for the Bridge potential so as to avoid the effects of stray current in the earth. The result shown by the Bridge is the resistance of a ground connection, assuming that the resistance of the water pipe is zero.

Fig. 7. Direct reference d.c. ohmmeter method. This method is not satisfactory on account of necessity of using direct current.

Fig. 8. Three-point ammeter-voltmeter method using alternating method using alternating current. The resistance to earth of $A = \frac{R_1 + R_2 - R_3}{2}$.

resistance of the ground under test plus the water system or other structure which is used as a reference. A high resistance joint in a water system is apt to introduce a serious error. The advantage of this method is that usually it can be made by ordinary ammeters and voltmeters and other equipment on hand.

The A.C. Wheatstone Bridge Direct Reference method is shown in Fig. 6. The result is given by the setting of the rheostat dial. The disadvantage of this method is that a head-phone must be used, and where stray current exists in the earth, it is very difficult to separate the tone of the buzzer from that of the stray current. Also the final result is subject to the same criticism as that just given, and low resistances cannot be measured accurately.

The Direct-Reference Ohmmeter principle would be a simplified form of the voltmeter-ammeter method shown in Fig. 7, but inasmuch as it uses direct current for the test, it is not generally practicable because of stray direct current in the earth and also polarization which always is present with grounded electrodes. Otherwise, this would be very simple because it is truly direct reading.

Three Point Method:

Where a direct reference ground, such as a water system, is not readily available, probably the most used and best known method is the so-called "three point" method, using for the purpose, either ammeters or voltmeters, or some form of Wheatstone Bridge arrangement. Fig. 8 shows the three point ammeter-voltmeter method and you will see that three different tests are made. In each case, two grounds are tested in series A + B, A + C and B + C. The resistance of any one of the grounds is then obtained from the solution of the three simultaneous equations with three unknowns:

$$\begin{aligned} A + B &= R_1 \\ A + C &= R_2 \\ \hline 2A + B + C &= R_1 + R_2 \end{aligned}$$

Subtracting

$$\begin{aligned} B + C &= R_3 \\ \hline 2A &= R_1 + R_2 - R_3 \end{aligned}$$

$$A = \frac{R_1 + R_2 - R_3}{2}$$

It is difficult to find a mechanical analogy which will show just why this works, but the mathematics of it is very simple and is well understood. It is essential, however, for accuracy that the resistance of the auxiliary grounds B and C be of the same order of resistance as the ground under test A. Otherwise, the equation will be unbalanced and slight errors in measurements will cause large errors in the results. In some cases it is very difficult to find or to secure auxiliary grounds which are as good as the ground under test, and that is one of the weaknesses of this method. Also, this method requires a source of power which preferably should be alternating current and of frequency different from that of the power system in the vicinity, so as to avoid the effects of both stray alternating and direct current in the earth. You will see from

the figure that three different tests are required, which means quite a number of connections—a total of six readings and four different calculations in order to test *one* ground. Obviously this is difficult if a large number of grounds are to be tested. These difficulties largely explain why ground testing has not been done to a very great extent up to the present time.

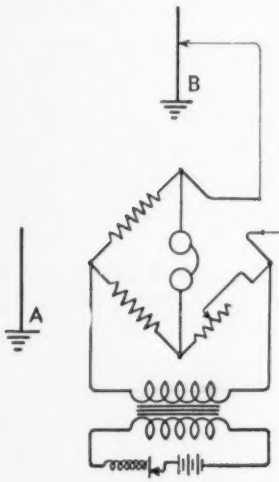


FIG. 9

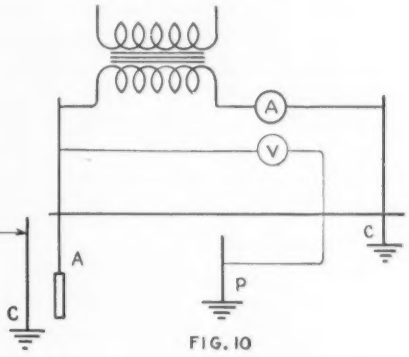


FIG. 10

Fig. 9. Three-point Wheatstone Bridge method. The resistance to earth of $A = \frac{R_1 + R_2 - R_3}{2}$.

Fig. 10. Straight fall-of-potential method using alternating current and an ammeter and voltmeter. The resistance to earth of A is equal to E/I, without further test or calculation, but the voltmeter reading will be affected by an appreciable resistance in the auxiliary ground P.

The three point method using a Wheatstone Bridge Fig. 9, with a buzzer is somewhat more simple than the three point ammeter-voltmeter method in that the sum of the two grounds in series is read on the Wheatstone Bridge and no outside source of current is required. It is still necessary, however, to calculate the final result, also the method is subject to the errors mentioned above if the resistance of the auxiliary grounds differs widely from the ground under test. The telephone receiver introduces serious difficulties if stray alternating current is present, and will injure a man if a disturbance should occur on the system near that location.

Fall of Potential Method:

The fall of potential method really presents the most simple and unique method of testing grounds and it is on this principle that the "Megger" Ground Resistance Tester works. Fig. 10 shows the fall of potential method in simplest form. This is somewhat easier to under-

stand than the three point method, because it resembles, in a way, the testing of the resistance of a length of wire. A circuit is made in the earth between the ground under test A and an auxiliary ground C. As explained above, the current distributes itself in the earth in all directions radiating from both A and C. When one gets far enough away from A, the resistance of the earth becomes negligible and therefore, one can obtain the total potential drop between A and the earth by placing the auxiliary ground P at a suitable distance from A. Care must be taken, however, not to place P too close to C, because the current from C which radiates into the earth, will cause an opposite effect. We find from careful tests of rods and pipes, that if P is 25 or more feet away from both A and C, correct results may be obtained; the exact arrangement on the ground makes hardly any difference so long as the proper distances are maintained. With this connection the resistance to earth of A is equal to E/I.

This would be a splendid method of testing grounds, except for the fact that one must use alternating current to obtain reliable results. This means that one must use A.C. ammeters and voltmeters. A.C. voltmeters are relatively low in resistance and therefore the auxiliary ground P may introduce a high resistance in the voltmeter circuit and cause an incorrect voltmeter reading. If we could use direct current and a high resistance voltmeter, we would eliminate the difficulty. This is *done* in the "Megger" ground tester, but cannot be done with ordinary D.C. instruments because of the effects of polarization and stray D.C. in the earth.

In all the methods for testing grounds which we have discussed so far, some manipulations, "balancing," or calculations are required. Until recently there has been no *direct reading* instrument for ground testing like we have direct reading instruments for testing current, voltage and insulation resistance. It remains for the "Megger" ground resistance tester to supply this feature. This instrument operates on the straight fall of potential principle. It makes the test by alternating current, so that the effects of stray current in the earth are avoided, and the results are indicated by a highly sensitive *direct reading* D.C. ohmmeter. It is so designed that it will operate consistently in places where stray current in the earth is considerable—satisfactory results having been obtained where this amounted to as much as 50 volts.

To understand how this method operates, consider Fig. 11. Current is supplied by a variable pressure direct current hand generator, and after passing through the current coil of the ohmmeter, is changed into alternating current for the test by the current reverser. A potential commutator converts the A.C. potential drop across the "ground" under test, into direct current again for actuating the potential coil of the ohmmeter, the two coils of the true ohmmeter are mounted on the same moving system and work in opposition electrically so that the reading on the

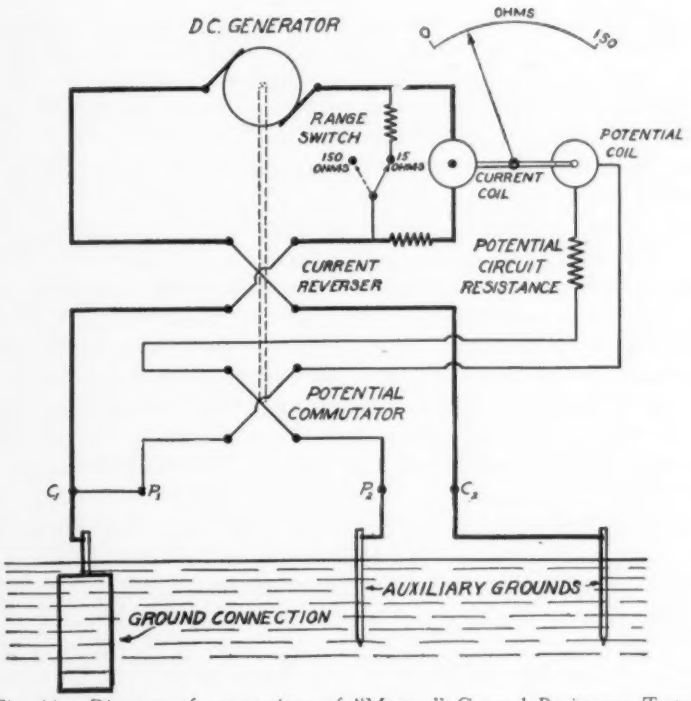


Fig. 11. Diagram of connections of "Megger" Ground Resistance Tester showing the true ohmmeter which operates on direct current and the reversing commutators by which the test is made on alternating current.

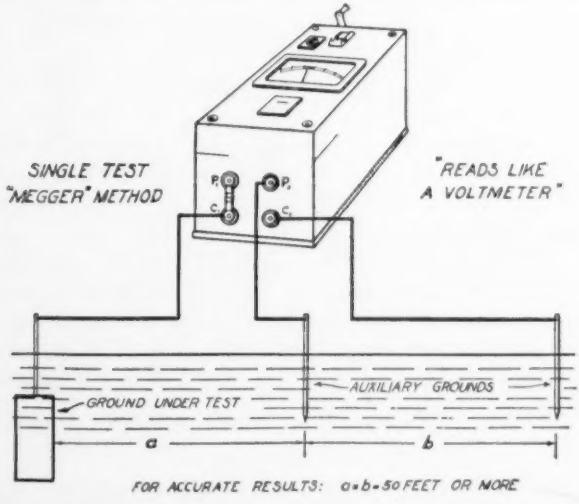


Fig. 12. Showing how to use the "Megger" Ground Resistance Tester. Make connections, turn the crank, and read the scale.

scale is the ratio between current and potential, or ohms. Any increase or decrease in the current supplied for the test changes the voltage drop in the same proportion; therefore, since the instrument is a true ohmmeter the two working elements are affected in the same proportion, and the reading on the scale remains constant at speeds considerably above or below normal. At normal speed the frequency of the testing current is 50 cycles per second.

The current reverser and potential commutator are mounted on the same shaft with the armature of the generator, and therefore, run in synchronism at all speeds. Thus the test is made by the alternating current of odd frequency, which avoids errors due to stray currents in the earth—either A.C. or D.C.—and the result is shown by a highly sensitive direct reading D.C. ohmmeter. The potential circuit of the ohmmeter has a resistance which is on the order of 10,000 ohms or more and the instruments have rated sensitivity and maximum accuracy when the resistance to earth of the two auxiliary ground connections are each 100 ohms or more. Thus a wide variation of resistance in these separate ground connections is permissible without introducing a serious error, even when testing comparatively low resistance grounds.

This method has the outstanding advantage that the operator sees at once the value of the thing he is testing by the direct deflection of a pointer on a scale—like an ammeter or voltmeter. It requires only two auxiliary connections, and all the "brains" are included in the instrument, so that the operator merely turns the crank and reads the scale.

A word should be said regarding the value of making ground tests, because it costs money to buy instruments, and more money to use them. Experience gained by power companies who have tested their grounds indicates definitely that the information is *necessary* to proper operation of their electrical systems. Many other companies are going very seriously into the matter—experimentally at first—but with the idea of establishing a regular routine of ground tests. One company who purchased a "Megger" ground tester recently expects to cover 3000 grounds, with two men, during the summer weeks. Another company reports that with their "Megger" ground tester they tested more than 380 grounds in five days. Many of these tests (not necessarily all of them) *could* be made, of course, by the old "three point" method, but the *time* required would make the cost exceedingly high. It is obvious that a selection of methods and instruments does not depend on first cost of a device, but rather upon how simple the method is to use, whether it will meet requirements as to range, and how reliable are the results.

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The first two weeks in July the Bausch & Lomb plant was closed for vacation.

Indicating and Integrating Ground Speed Indicator

*Prof. Adam Hofmann, Dayton, Ohio**

MR. W. C. ROGERS of San Antonio, Texas, spent some time at the Mechanical Laboratory of the University of Dayton, Dayton, Ohio, conditioning and adjusting a device for measuring and integrating ground distance covered by aeroplanes in flight.

He calls this instrument a ground speed indicator. It is really more than that. It will accomplish for the aeroplane what a speedometer does for an automobile, indicate the rate of speed at any moment and aggregate the total distance covered in a straight course. It has in addition an arrangement showing the position of the plane on a map as it speeds over the ground.

As a result of observation, attendance and discussions with the inventor covering the claims as set forth in his patents, the following remarks will be in order. Acceleration and retardation are observed by a well known principle of mechanics based on inertia of matter. At this juncture an ingenious arrangement of two electrical circuits permits measuring the degree of acceleration or retardation as against time and the summing up of this phenomenon in time, thus showing the distance in miles covered by the aeroplane. An analysis of the method used will convince anyone that the principles involved do not run counter to any well-established laws of physics, in other words the process is founded on known physical phenomena.

Some painstaking experimentation must still be gone through to determine the electrical characteristics of the motors best suited to the job to secure a perfect transfer of the acceleration into electrical equivalence. This task is by no means a hopeless one and should be accomplished in a few months.

Some further problems will develop when we consider the odd positions to which the instrument will be subjected in flight, but these have been considered and solutions suggested.

Mr. W. C. Rogers is to be complimented for his success in offering a solution of a problem presented by aviators and which had not been solved up to the present day.

Aviators traveling over large expanses of water will find in this instrument an easy means to determine their position. Through mist and fog and clouds and rain and snow they will know what progress they are making in their course.

The instrument is eminently suited for ships at sea because it can more readily be kept in ideal conditions for registration of speed and distance and will enable a ship to know the position when astronomical observations become impossible.

*Dean of College of Engineering and Director of Mechanical Laboratory, University of Dayton.

The Scientific Instrument of To-day— The Industrial Instrument of To-morrow

IT is agreed that instruments are becoming more universally used from day to day. Now the problem is —how can we most readily obtain this profitable business?

THE layman must be EDUCATED to the thousand and one uses of instruments. He must be MADE to appreciate the unusual possibilities coupled with their use in his plant.

SALESMEN are required that will constantly bring home to him the same facts in new and interesting ways. Only constant "hammering" will make him realize the importance of the use of instruments. Time is necessary for such an achievement.

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INSTRUMENTS

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are your salesmen

Received each month they furnish the proper background for the efforts of your representatives.

New Instruments

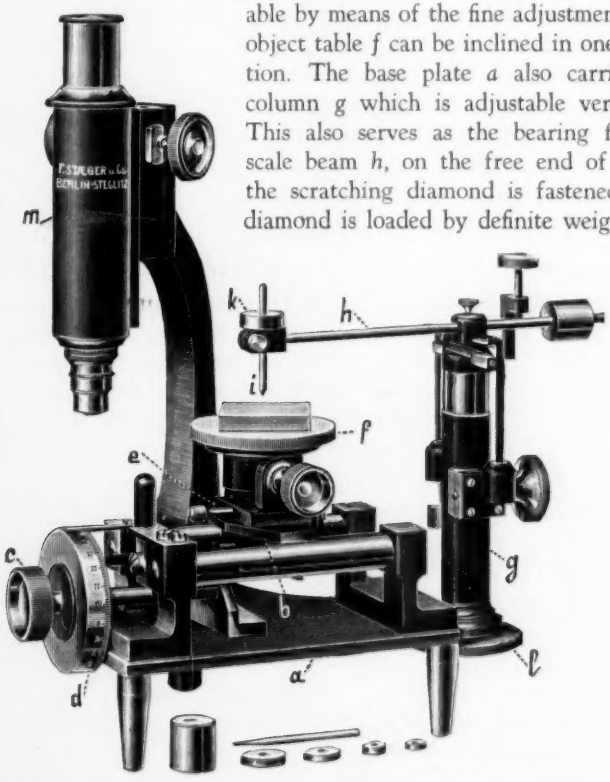
Recently Developed by Instrument Manufacturers

Scratch Hardness Tester

(F. Staeger & Company)

ON the base plate *a* are two bearing blocks, which hold the cylindrical guides for the measuring slide *b*. This is moved by the screw *c*, on which the divided drum *d* is fastened.

On the slide *b* at right angles to it is a cross slide *e*, in order to be able to move the object table sitting on it sideways. The cross-slide is adjustable by means of the fine adjustment. The object table *f* can be inclined in one direction. The base plate *a* also carries the column *g* which is adjustable vertically. This also serves as the bearing for the scale beam *h*, on the free end of which the scratching diamond is fastened. The diamond is loaded by definite weight *k*.



After loosening the set screw *l* the column *g* can be turned about its axis and therewith the scale beam can be swung to the side. The microscope *m* with cross-hairs can also be swung in and out and brought over

the object table. Either the scratch diamond or the microscope can be brought over the table, on which lies the piece to be tested, without removing this from the table. The method of procedure is as follows: One lays or sticks the piece to be tested in the regular manner on the specimen table *f and levels it*. Then the diamond with its point is brought over it, loaded with a certain weight *k* and one then moves the table with the sample on it by turning the micrometer screw. The procedure may then be repeated, after the object table has been displaced a small distance horizontally by means of the cross-table *e*, if one wants to make a number of scratches close together, probably with different loads. Then the balance beam with the diamond is switched out by a sideward movement of the column *g* and the microscope is switched in. The object table *f* must naturally be turned through an angle of 90 degrees if one wants to measure the width of the scratch. The table *f* can easily be removed, so as to fasten the specimens to it. Also the balance beam can be taken from its bearing, if one wants to change the diamond or put in a sharpened point of another material, for example, steel. It is much better to take the balance beam off in such a case to prevent damage to the bearing.

The divisions on the dividing drum is read directly in 0.001 mm. The measuring range is 30 mm.

To the Instrument Companies

IN order to keep the readers of INSTRUMENTS in touch with the latest developments in industrial and scientific instruments, the editor again urges all manufacturers of such instruments to keep him informed of all new instruments or important improvements made by them as soon as they appear, by letting him have descriptions of about 1000 words including construction, performance, and applications.

Pass the Subscription Blank in the back of this issue to the following men in your plant. You will be doing them a service as they will be interested in receiving this periodical regularly:

Works Manager	Chief Inspector
Superintendent	Chief Electrician
Consulting Engineer	Instrument Man
Chief Engineer	Pyrometer Man
Mechanical Engineer	Chemist
Electrical Engineer	Metallurgist
Plant Engineer	Physicist
Maintenance Engineer	Research Engineer
Production Engineer	Test Engineer
Efficiency Engineer	Plant Librarian

Reliance Tachometers and Speed Indicators

(Barbour Stockwell Company)

EFFICIENT operation of machinery is the criterion of the present era. There is waste in an organization if its machinery is not working to capacity. The opposite is likewise true. A machine is being wasted if it is forced to do more than its regulated quota.

Certain processes in industry must be performed according to a certain schedule, or the finished product will be spoiled or turned out below par. Hence the growing demand for instruments to regulate the speed and rate of production of machinery.

The Reliance Tachometer has been adapted to indicate surface speeds, rate of unit production per hour, revolutions per minute and other measures.

The working principle of the Reliance Tachometers is centrifugal force operating through the medium of an evenly balanced three-weight governor, running in ball bearings. This governor absolutely controls the movement of the indicator in both directions over the dial.

The tachometer functions as follows: As the shaft revolves under increasing speed, the governor weights fly outward, causing the grooved hub to slide along the shaft. This actuates gearing which moves the pointer around the dial. When the speed decreases, the spiral spring around the shaft causes the sliding hub and weights to operate in the reverse direction and returns the pointer to zero as the revolutions cease. The instrument has a small number of working parts and has a very simple construction.

The automatic coupling eliminates any possibility of trouble or locking of parts when connecting the flexible shaft or other driving member.

The flexible shafting used in connection with the tachometer is constructed of 17 strands of music wire, wound and rewound in compact form. This shafting is positive in its action. There is no slack to take up, either in starting or change of speed; it will operate perfectly in a small

circle and at high speeds. Sharp bends, however, must not be made within three inches of either terminal.

The flexible shaft is suspended in ball bearings. This eliminates friction, prevents all chance of disconnection from the instrument, insures a free running shaft and a steady pointer over the dial. Flexible shafting is furnished in any length up to 35 feet. For connecting two lengths, where the distance is greater than 35 feet, a flexible shaft coupling can be supplied.

Reliance tachometers are supplied in the following R.P.M. graduations:

25-300	100-1200	300-3600	500-6000	800- 9600
50-600	200-2400	400-4800	600-7200	1000-12000

The high-speed tachometers have a counter reading up to 99,999 and repeat. This counter does not run continuously; it is operated by means of a button at the side of the case with a catch incorporated to keep the counter engaged when required. The accuracy of the pointer may be verified by running the counter over a period of a few minutes and comparing the revolutions recorded to the speed indicated by the pointer. Counter instruments will be found invaluable especially on test stands, as the actual turnover may be recorded.

For the Textile Field. Tachometers are available to measure production in feet or yards per minute or any special arrangement to meet particular requirements.

For the Motion Picture Field. The film speed indicator enables the projectionist to know at all times his exact operating speeds.

For Newspaper or Printing Presses. The Reliance outfit adapted to this use permits the operators to maintain efficient production speeds and to know without guessing the actual speeds they are running.

For Marine and Aircraft Use. The tachometer is essential for the careful regulation of engine speed. The counter on this instrument will be found convenient when navigating in foggy weather, for reckoning distance by time and speed of the propellor, also for any purpose of recording the actual revolutions over a period of time.

For Industrial Use. Special adaptations of Reliance models and outfits can be arranged to meet requirements—to indicate 100's, 1000's, etc., of units per minute, per hour, or any other production measure over a specified period of time. The counters can be used for checking production schedules, machine operation and operator attendance.

RELIANCE TACHO METERS

Booklet No. A-9

REVS. per MINUTE, SURFACE SPEEDS, PRODUCTION per MINUTE, per HOUR, COUNTERS

BARBOUR STOCKWELL COMPANY
CAMBRIDGE MASS.

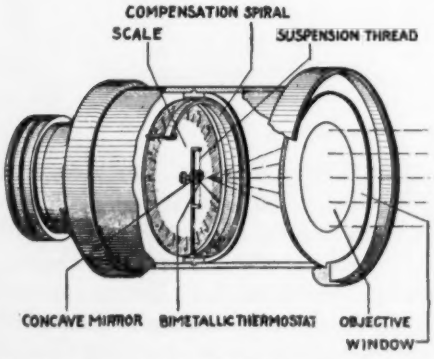
The K & S Pocket Radiation Pyrometer

(Colonial Supply Company)

THIS instrument is a new development of the "total radiation" type pyrometer. It is illustrated in the figures, and it has many novel features of engineering interest, and of considerable value in all high temperature operations.

The fundamental principle on which this pyrometer operates is the measurement of the total radient energy emitted by a hot body, whose temperature is to be determined. The theoretical relation between the temperature of a "black body" and the radient energy emitted by it, is given by the Stefan-Boltzmann law, in accordance with which the radiant energy at any particular temperature is a direct ratio of the fourth power of the absolute temperature of a perfectly black body.

At the focus of a collecting lens having a diameter of 1⅛ inch and a 2 inch focal length is located a bimetallic spiral of about 0.1 inch diameter and 0.001 inch thickness. A pointer, joined to the spiral, which moves in front of a scale divided in temperature degrees, permits observing the change of the spiral. In order to obtain the highest possible sensitivity of the instrument, the spiral is fastened to a stretched wire 0.002 inches in diameter and behind the latter a small concave mirror is set.



With the practicable use of the radiation energy, the heat absorption in comparison with other types is extremely small, wherefore the spiral attains a considerable temperature even with low radiation and indicates within a few seconds the heat intensity investigated.

Due to this condition and the compensated form of the instrument, the K & S pyrometer is especially suitable for portable use. In order to compensate for variations of room temperatures, the scale can be turned and its momentary position relative to the pointer is automatically regulated by a compensation spiral in a very ingenious

manner. This does away with a very considerable difficulty of similar pyrometer construction in that the indications of the instrument are no longer dependent upon previous measurements or the height of the surrounding temperature.

The scale is transparent and can be seen at the same time the glowing surface is viewed through the occular, enlarged about eight times. Thereby a very high accuracy of reading is obtained, as even the slightest movement of the spiral is clearly shown. To protect the eye against the bright rays when measuring high temperature, a red glass is provided to place between the eye and the ocular.

The K & S Pocket Pyrometer contains all the necessary parts for accurate temperature measurement in one small portable unit. All working parts are completely enclosed and protected in a dust proof housing. The overall dimensions being 6 in. long and 2 in. in diameter; the weight is only 6 oz.

The instrument has a "distance factor" of about 12, which means that the distance from the instrument to the furnace opening or piece of material whose temperature is to be measured should not be more than 12 times the diameter of the opening or piece. The instrument is self contained, requires no accessories of any kind. The user is not required to perform any complicated measurements or comparisons; the readings obtained with the pocket pyrometer are independent of the personal error, as the operation of the instrument is automatic. The instrument is handled as easily as a telescope, and can be used by anyone without previous instruction.

The available scale ranges are:

1100-2600 deg. F	600-1400 deg. C.
1100-3000 deg. F.	600-1600 deg. C.
1100-3300 deg. F.	600-1800 deg. C.
1100-3700 deg. F.	600-2000 deg. C.
1100-4000 deg. F.	600-2200 deg. C.

APPLICATIONS

Iron and Steel Plants. Cupolas, puddling furnaces, crucible furnaces, open hearth furnaces, soaking pits, heating furnaces, annealing, hardening and carburizing furnaces, forging, rolling.

Coke and Gas Plants. Coke ovens, coal-gas retorts, combustion, chambers of retort benches, water-gas plants, gas fired furnaces.

Ceramic Plants. Glass melting furnaces, Fourcalt machines, enameling kilns, glazing kilns, brick kilns.

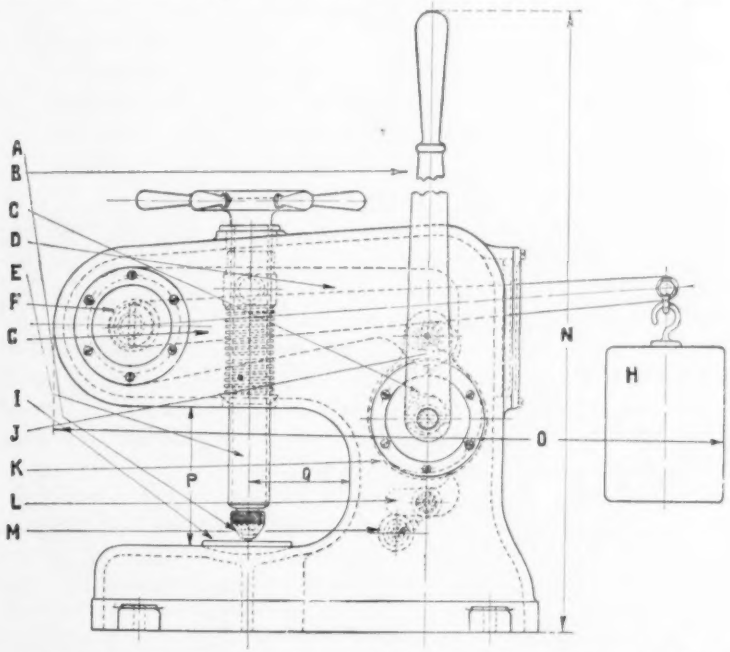
Boiler Furnaces. Boiler fuel bed, boiler walls.

Miscellaneous. Rotary cement kilns, rotary ore sintering kilns, incinerator furnaces, continuous furnaces, checking permanently installed pyrometer systems.

Hardness Testing Machine

(Brown Bayley's Steel Works Limited)

THE best known of all methods of measuring the hardness of metals is that devised by Brinell, in 1900. According to this method, which is now generally accepted as a standard, a 10 mm ball in contact with the specimen is loaded with a pressure of 3,000 kilograms. The diameter or depth of the ball impression is then measured and the results, or figures calculated from them, are taken to indicate the hardness of the material. For softer metals, such as copper, brass, etc., the 10 mm ball is usually loaded with 500 or 1,000 kilograms. (Weights can be supplied with this machine to give any load between 500 and 3,000 kilograms.)



The Johnson hardness testing machine is used according to the Brinell system. It has been devised to ensure rapid and accurate working and at the same time withstand the rough workshop use, requires practically no attention or adjustment, and be easily movable from place to place without detriment. In addition to its obvious advantages over the hydraulic type of machine there are no springs, knife edges, or multiple levers to get out of order, and all moving parts work on ball bearings.

Description of the Machine. Pressure is applied to the steel ball (A) by means of the lever (B) and ball-bearing eccentric (C) through the single lever (D) and screw (E). The other end of the lever (D) is held

by the eccentric in ball bearings (F) to one end of which is attached the lever (G) and weight (H). The weight (H) is raised by the eccentric (F) when the pressure on the ball (A) reaches 3,000 kilograms; any further movement of the operating lever (B) tending to apply further pressure on the ball only results in raising the weight.

General Dimensions of the Two Type Machines Available

Type "F" Machine	
Overall Height (N)	28 inches
Overall Length (O)	22 inches
Distance between table and top (P)	4½ inches
Center of inside radius to center of screw (Q)	3½ inches
Total weight	120 pounds
Type "E" Machine	
Overall Height (N)	36 inches
Overall Length (O)	29 inches
Distance between table and top (P)	11½ inches
Center of inside radius to center of screw (Q)	5 inches
Total weight	196 pounds

Method of Making Test. The specimen to be tested (which must have a smooth flat surface) is placed on the table (I). The adjusting screw (E) is then brought down until the steel ball rests on the prepared surface of the specimen. The lever (B) is then pulled forward until its weight (H) rises, allowing the pawl (J) to fall into the toothed sector (K) which will automatically prevent any further movement of the lever (B). The load may be kept on for any desired period by means of the retaining pawl (L) which is moved in and out of position by means of the knurled handle (M). The lever is now placed in its original vertical position and the adjusting screw raised.

For thin articles or articles which the 10 mm impression would deface, it is recommended that a 5 mm ball and a pressure 750 kilograms be used. The hardness number is obtained from the table for 10 mm ball and 3,000 kilograms by multiplying the 5 mm impression by 2 and reading direct from the table.

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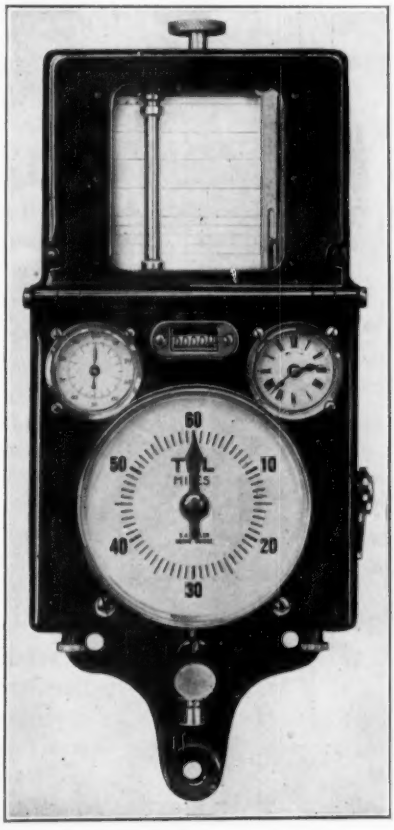
Advertise for the men your salesmen may never see, but the men who influence sales. Advertising goes through doors that are closed to your salesmen—and to your competitors' salesmen. Advertising does more than influence customers on whom your salesmen do not call. The repetition of your selling points impresses them on the minds of prospects. Men who have learned something of your company and your instruments from your advertising are easier men for your salesmen to see—they are easier men to sell. Your advertisement in INSTRUMENTS creates confidence and prestige.

The Hasler Tel Vehicle Recorder

(R. W. Cramer & Company)

THE Hasler Tel Recorder for busses offers an effective, simple and entirely reliable means for the control of operation and supervision of vehicles at termini and along the routes. It simplifies the daily routine of dispatching, route inspection and checking-up of schedule maintenance; and in fact, makes possible considerable reductions in the personnel required to keep the busses moving according to schedule.



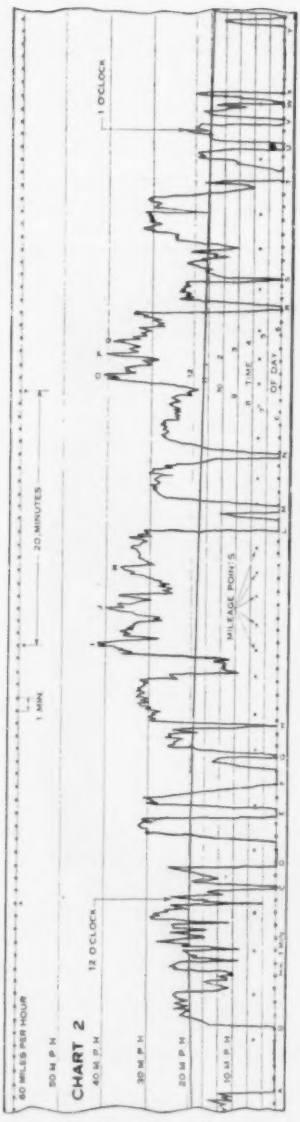
It is complete in function, accurate in operation, direct in its readings and reliable in long and hard service. It can be easily installed on any vehicle having a speedometer drive shaft, and furnishes a permanent record of the following operating data:

1. Vehicle speeds attained every second.
2. Time and duration of stops.
3. Location of stops on a mileage basis.
4. Time and duration of runs.
5. Time and duration of lay-overs.
6. Total operating time.
7. When the vehicle was in operation.
8. When the vehicle was idle.
9. Schedule speeds.
10. Average speeds.
11. Trip and total mileage.
12. Time of day, in hours and minutes.

Obviously such records, in addition to their importance in operation control, also provide valuable information in connection with the investigation of accidents.

HOW OPERATION IS RECORDED

The instrument is shown in the illustration. The paper moves horizontally at a set speed while the vehicle is moving. The time, which is marked by the vertical movement of a scriber connected with the eight-day clock, is therefore an oblique line; ascending from 6 to 12 o'clock



and descending from 12 to 6 o'clock. In order not to waste paper during long idle periods, the paper feed ceases five minutes after the vehicle comes to a stop, and then the time line, of course, becomes verticle.

The exact hours are indicated by the points at which the time line crosses the parallel lines printed on the paper. The minutes are marked by the closely spaced dots at top and bottom. To facilitate the reading of minutes, every twentieth is marked by a double dot.

The vehicle speeds are recorded by another scriber connected with the speed indicator, and any point on this graph represents the vehicle speed attained that instant. In order that the time and speed markings may not conflict, the time is marked 1/8 inch to the left of the speed graph.

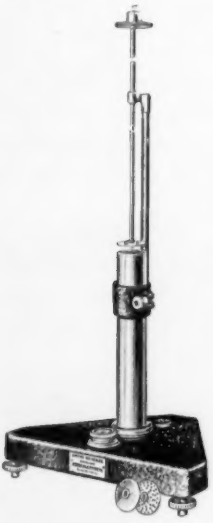
Every mile traveled is recorded by a dot in the lower part of the chart, each mileage dot being displaced by 1/8 inch to the left of the time marking in order not to conflict with the time scriber. The total mileage accomplished by the vehicle from the time of installation, is registered on the odometer directly above the speed dial.

While the daily routine of handling the charts may, in details, vary with the requirements of each driver, in general it is as follows: At the end of the day's run the record is removed and identified by marking on it the date, name of driver, number of vehicle and the route. It is then turned into the dispatcher's office, where it is tallied with a "key" or master chart of the route. Any irregularities of operation, such as starting or arriving late, or over speeding, are noted for investigation. The other data, such as mileage, operating hours, etc., is audited for schedule analysis and operations accounting, and handled in accordance with the established routine.

The Gardner Mobilometer

(Fisher Scientific Company)

THE practical workability of an industrial fluid bears a direct relation to its consistency. The consistency varies with the quantity and quality of ingredients which tend to "thin" or "thicken" the product. A standard product must have a uniform consistency and that consistency should be just right for the purpose intended.

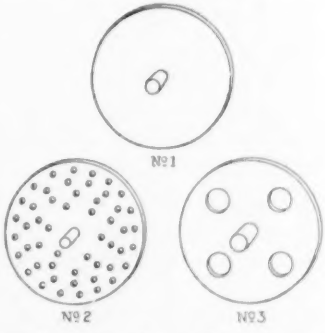


Paints, varnishes, lacquers and enamels are products where this property determines how the products will flow, brush or spray.

Various types of hydrometers have been employed to measure consistency but all are unsatisfactory because thinners have different specific gravities so that the hydrometer readings do not correctly indicate the consistency. The addition of a thinner with a gravity approximating that of the original material will have little or no effect on hydrometer readings.

Dr. H. A. Gardner has devised an instrument called the Mobilometer, which measures the mobility (or workability) of a product. The mobility differs from viscosity in that the flow is produced by a definite degree of pressure.

The Gardner Mobilometer comprises a brass tube, in which is placed the material to be tested. An etched mark on the inside of the tube indicates the level to which it is filled. A plunger of standardized dimensions and weight carries a disc at its lower end and a scale pan on its upper end. The time required for the plunger to fall through the material in the tube is noted by means of a stopwatch. A sharp click is heard when the plunger strikes the bottom of the tube.



Three standardized discs for attaching to the plunger are supplied: No. 1 is solid, No. 2 has a series of small holes, and No. 3 has four larger holes. Disc No. 1 is used for less viscous materials; disc No. 2 for those of medium viscosity and disc No. 3 for materials of high viscosity.

The weight and size of these discs, as well as the size and spacing of the holes, are controlled within small tolerances, so that readings with the different discs under different weight conditions, can be interchanged.

A wide range of materials can be tested by employing different discs and adding different gram weights to the scale pan at the top of the plunger. Most tests are made at 68 degrees F. (room temperature), but the cylinder can be first immersed in a bath of any desired temperature.

The brass cylinder screws into a boss on the center of the base; the bottom of this brass cylinder is removable for cleaning. Adjustable feet and a circular level on the base, enable the operator to adjust this instrument to an exact level. Operating directions are supplied with the Gardner Mobilometer.

In the paint and varnish industry this apparatus is being used to control the mobility of dipping paints, brushing enamels, and japans, as well as spray lacquers, and serves as a check on the evaporation of their volatile constituents. It serves as a gauge for determining quality and quantity of pigment and thinner to be added to batches already in use. Printing paints for linoleum can be tested for their thinner content. Linseed tung and mixed oil paints can also be standardized.

Some of the products of the non-paint industries in which the mobilometer is being used as a standardizing or control instrument are: Tomato catsup, cream, mayonnaise and other food products, vaseline, mineral oils, light tars and pitches, glues, soap solutions, emulsions, etc.

Other applications will present themselves to the reader. It is only necessary to standardize a product in terms of mobilometer readings, after which this instrument can be used to control the ingredients of the product, or the final product itself.

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THE BROWN INSTRUMENT COMPANY BUILDS NEW PLANT ADDITION

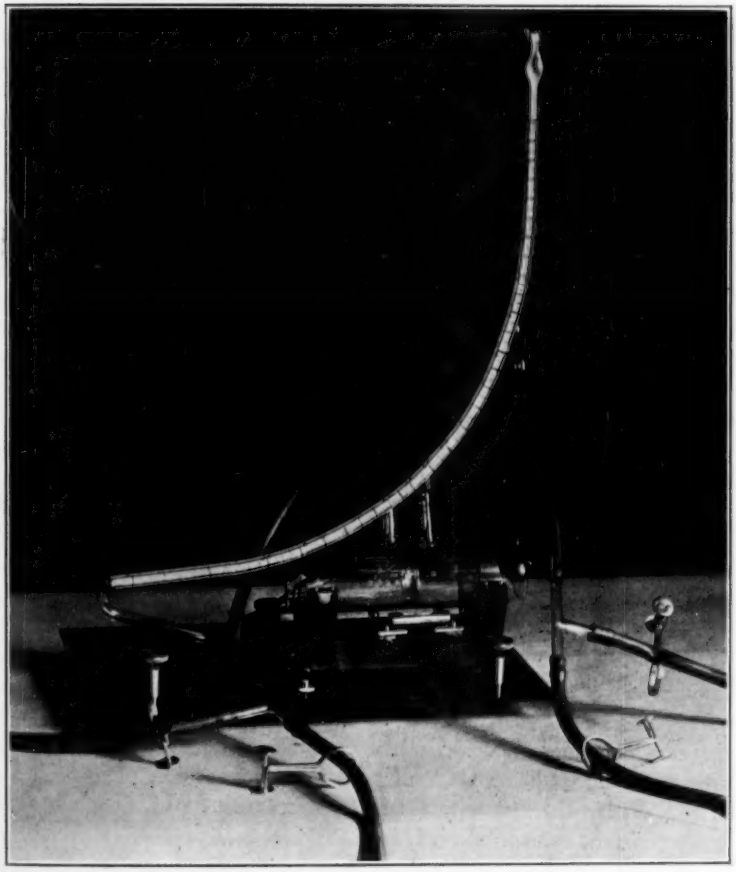
The Brown Instrument Company of Philadelphia, makers of industrial and power plant indicating, recording and automatic control instruments for measuring temperature, pressure, fluid, flow, machine speed, percent CO_2 in furnace flue gases, etc., is building another addition to its plant. The new structure will be 60 ft. long by 44 ft. deep and two stories in height. Heavy foundations will permit other floors to be added as future requirements may demand. Construction will be strictly fireproof throughout. The rapid growth of the company and the enlargement of its line has made necessary this latest plant addition, the third within eight years. Its primary purpose is to provide research facilities commensurate with the needs imposed by the rapid expansion of the company's interests with respect to variety of products and the continually widening application of Brown Instruments to the activities of industry and science.

Neumann Micromanometer

(Robert Mueller Kommandit Gesellschaft)

THE micrometers used to date possessed constructional defects, which made the measurement difficult and uncertain. As such are mentioned:

1. The possibility of forming and entrapping of air and gas bubbles.
2. Numerous connections, which resulted in danger of leakage.
3. Forcing through of the liquid column with sudden pressure increases.
4. Lack of a reservoir for the measuring liquid forced out.
5. Lack of transparency, due to this uncertainty as to the condition of the instrument and satisfactory operation.
6. Necessity of putting in new measuring tubes and change of the zero point with changing pressures.



These disadvantages are especially objectionable in plant investigations, where one deals with dirt and heat, lack of time and poor illumination, sudden pressure change and the lack of skill of untrained observers. In many cases therefore the micromanometer under such conditions failed utterly, in many cases an unsuitable micromanometer destroyed an extensive test costing considerable time and money.

The measuring instrument described below was developed by the Waermestelle of the Vereins Deutscher Eisenhuettenleute, avoided all the above listed disadvantages.

A measuring tube bent to any desired law and going over into a vertical arm in its upper part is combined with two glass containers, of which one serves as a reservoir, while the other serves the purpose of catching the liquid thrown over. For connection to the measuring point two tubes connected to the two glass containers serve. These are connected somewhat sideward and extend toward the side to permit a convenient and safe connection of the connecting tubes. At the same time these two tubes serve for filling and emptying the mentioned containers, whereby the emptying is accomplished by means of a capillary tube stuck through. The whole is made of one piece of glass. Errors due to leakage cannot occur, if the connected tubes do not leak. Due to the avoidance of the horizontal parts air bubbles can not be entrapped and the use of glass as the material permits an instantaneous inspection of the instrument at any time. With the exact measurement of very slight pressures in the lower part of the measuring tube, it is also possible to read pressures or difference in pressures up to 250 mm of water and more in the center and upper part of the bent tube. A throwing out of the liquid in the measurement of small pressures and with sudden pressure increases is prevented up to the maximum pressure. If the liquid should in exceptional cases be forced over, it enters the right container, where it is held back. A hanging of liquid drops in the opaque connecting tube or the formation of a water sack and measuring errors occasioned thereby are avoided.

The level for setting the instrument is connected solidly with the glass body. For tests the whole instrument with its bearing is placed in a case, which protects it against damage and which when carried can be closed in front and back by means of covers. Three leveling screws serve for the correct setting of the instrument. With the standard instrument the slope in the neighborhood of the zero point is 1:11, herewith when filled with alcohol for each mm of water a movement of 14 mm results, so that an accuracy of reading of 1/50 mm is possible. With a special auxiliary level the slope can be varied at will and the movement and accuracy can be increased at will, so that the instrument can be used for the smallest pressures and for the most exact determinations. Another advantage is that being made of glass it need not be emptied each time after use as in the case with the metal micrometers which are not chemically resistant even to alcohol.

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- ☐ 4. Hardness Testing Machine
- ☐ 5. The Hasler Tel Vehicle Recorder
- ☐ 6. The Gardner Mobilometer
- ☐ 7. Neumann Micromanometer

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Instruments Book Shelf

Orders for copies of the books reviewed in this section can be sent to Instruments Book Shelf, care of Instruments Publishing Company, 1117 Wolfendale Street, Pittsburgh, Pa.

THE MODERN CALORIMETER. *Walter P. White.* Chemical Catalogue Company, New York, N. Y., 1928. Cloth, 194 pages, $4.00.

REVIEWED BY ARTHUR SCHRODER

This book is one of the series printed under the auspices of the American Chemical Society by arrangement with the Inter-Allied Conference of Pure and Applied Chemistry. Its purpose is to promote research in calorimetry. The book itself is one which will not appeal to beginners in the subject, but does appeal rather to the research man who has a good basic knowledge of the principles involved in calorimetry, and who desires to obtain a general survey of the progress in this field of work in the last few years.

The subjects of Thermal Head, Timing, Cooling Rate, Thermal Leakage, Lag and Evaporation are all discussed in minute detail, with conclusions drawn with a view toward controlling these factors. The various types of calorimeters are discussed pro and con. The final chapter deals with the application of the conclusions drawn in the earlier chapters to calorimeter design, and the planning of installations of the various degrees of precision.

This book crystallizes in its two hundred pages the current theories and practices of modern calorimetry. The conclusions drawn should serve as a guide to manufacturers of calorimeters, as well as to the actual user.

Take Laboratory Accuracy into the Shop

IF you work to close limits, the Bausch and Lomb Toolmakers' Microscope is practically indispensable. Accuracies as close as .0001 are quickly and precisely determined. Yet the manipulation of the instrument is simplicity in itself.

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Aircraft Instruments

The Pioneer Instrument Co., 754 Lexington Ave., Brooklyn, New York, have available a chart illustrating full size the dial faces of their air speed indicators.

Binoculars

Bulletin G-11, IV-28 issued by the Bausch & Lomb Optical Company, Rochester, N. Y., describes and illustrates their Stereo-Prism Binoculars.

Bausch & Lomb Magazine

The June issue of the Bausch & Lomb Magazine, of the Bausch & Lomb Optical Company, Rochester, N. Y., contains the following articles: Summer Season of Opportunity. The Lens—that's the Question. Inset of Bifocal Segments.

Dial Gauge

The Leuner-Staeger Dial Gauge is illustrated in Druckschrift: Pruef 5 issued by F. Staeger & Co., Berlin-Steblitz, Germany. This literature is printed in German.

Extensometer

Druckschrift: Pruef 2 issued by F. Staeger & Co., Berlin-Steglitz, Germany, covers the Okhuizer extensometer. Separate leaflets describe the Martens-Kennedy Extensometer and the Martens Mirror extensometer. This literature is printed in German.

Experimenter

The General Radio Experimenter for May contains the following articles: The Development and Use of the Hydrophone. An Artificial Cable Box. A 600,000 Ohm Potentiometer. Plug-in System for Audio Frequency Couplers.

The General Radio Experimenter for June contains the following: Magneto-Striction Oscillators, Inductances Capacity—Frequency Impendance Chart. This publication is published by the General Radio Company, Cambridge, Mass.

Feed Water Regulators

The Vigilant Feed Water Regulator is described and illustrated in a recent publication of the Chaplin-Fulton Mfg. Co., 28 Penn Ave., Pittsburgh, Pa.

Fluid Meters

Bulletin 36 issued by the Bailey Meter Company, 1050 Ivanhoe Road, Cleveland, Ohio. covers their mechanically operated fluid meters for measuring steam, water, air, gas, oil, etc.

Gas Regulators

Fulton Gas Regulators with automatic cut-off for natural gas and the Fulton duplex sensitive gas governor for manufactured gas are covered in a recent bulletin of The Chaplin-Fulton Mfg. Co., 28 Penn Ave., Pittsburgh, Pa.

Ground Ohmer

Survey Number SI-51-SZ covers the Sticht Ground Ohmer used by A Large Mid-Western Power and Light Company. Copies may be obtained from Herman H. Sticht & Co., 21 Park Row, New York, N. Y.

Hydrogen—Ion Comparators

Hellige pH—Comparators with nonfading standard color discs for the determination of hydrogen ion concentration is described in List 110-1-28 of Hellige-Klett, Inc., 179 East 87 st., New York, N. Y.

Hardness Tester

Druckschrift 3 issued by F. Staeger & Co., Berlin-Steglitz, Germany, covers the Scratch Hardness Tester Manufactured by them. A separate leaflet issued by this company covers the Martens scratch hardness tester.

Hardness Testing Machine

Brown, Bayley's Steel Works, Ltd., Leeds Road, Scheffield, England, have issued List No. 17 to cover the Johnson Hardness Testing Machine.

Insulation Tester

Bulletin No. 170 of Dr. Th. Horn, Leipzig, Germany, covers the various types of Electrical Insulation Testers manufactured by this company. This literature is printed in German.

The Laboratory

Volume One, Number Three of The Laboratory published by the Technical Service Department of Fisher Scientific Company, 711 Forbes St., Pittsburgh, Pa. The little booklet contains some very interesting articles.

Microscope

The Leitz Universal Chemical Microscope, Model "Chem" is described and illustrated in Pamphlet No. 1129 issued by E. Leitz, Inc., 60 East 10 Street, New York, N. Y.

Mobilometer

The Gardner Mobilometer for measuring the consistency of dairy creams, ice cream mixes, syrups, gelatines, glue, mineral and vegetable oils, paints and lacquers, light tars and pitches, soap solutions, etc., is described in a recent leaflet issued by the Fisher Scientific Company, 711 Forbes St., Pittsburgh, Pa.

Microscope Accessory

The new No. 45 Wide Field Attachment for increasing the usefulness of the microscope is illustrated in a recent leaflet of the Bausch & Lomb Optical Company, Rochester, N. Y.

Measurement of the Resistance to Earth of Ground Connections.

Is the title of Bulletin 1185 recently issued by James G. Biddle, 1211 Arch Street, Philadelphia, Pa. This bulletin applies especially to the "Megger" ground resistance tester.

Ohm-Volt-Amperemeter

The pocket Ohm-Volt-Amperemeter is covered by leaflet No. 169 issued by Dr. Th. Horn, Leipzig, Germany. The leaflet is printed in German.

Price List

The Bausch & Lomb Optical Company, Rochester, N. Y., have issued a revised Price List of Microscopes, Microtomes, Colorimeters, Spectrometers and Refractometers.

Productometer

A Reliance Tachometer has been developed by the Barbour Stockwell Company, 205 Broadway, Cambridge, Mass., to indicate the rate of newspapers produced per hour on standard newspaper presses. This is likewise adaptable to indicate rate of units produced per minute, per hour, etc., for other adaptations, described in an illustrated letter-circular.

Precision Controller

A recent leaflet issued by the American Schaeffer & Budenberg Corporation, 338 Berry Street, Brooklyn, N. Y., describes their precision controller, prices are also given.

Phase Sequence Indicator

The Standco Phase Sequence Indicator is briefly described and illustrated in Price Sheet No. 514 issued by Herman H. Sticht & Co., 21 Park Row, New York, N. Y.

Potentiometer

Bulletin No. 763 just issued by the Leeds and Northrup Company, 4901 Stenton Ave., Philadelphia, Pa., completely describes and illustrates the Brooks Deflection Potentiometer. This bulletin also discusses the application of deflection potentiometers.

Speed and Drift Indicator

A leaflet on the above has just been issued by The Pioneer Instrument Company, 754 Lexington Ave., Brooklyn, N. Y.

Surface Condenser Leakage Detection

Circ. 4964-G50-228 issued by Leeds & Northrup Company, 4901 Stenton Ave., Philadelphia, Pa., covers the L. & N. Conductivity Records for the detection of condenser leakage.

Scales

A recently received folder of catalogues issued by the Toledo Scale Company, Toledo, Ohio, contains complete information on the various scales manufactured by this company.

Tube and Pipe Inspection Device

Druckschrift Pruef. 1 issued by F. Staeger & Co., Berlin-Steglitz, Germany, describes the Tube Inspection Device manufactured by this Company. This literature is printed in German.

Tachometers, Tachographs and Revolution Indicators

The following literature has been received from Dr. Th. Horn, Leipzig W34, Germany: Liste No. 216—Portable Tachometers; Liste No. 248a—Tachometers and Tachographs; Liste No. 218—Eddy Current Tachometer; Liste No. 217 Conveying Machinery Precision—Tachograph; Liste No. 214 Operation and Revolution Counters; Liste No. 302 Electric Remote Revolution Indicators for Aircraft; Liste No. 301 Electric Remote Revolution Indicators for Marine Use. All this literature is printed in German.

Tachometers for Outboard Motors

"Racing" is the title of a recent leaflet issued by the Barbour Stockwell Company, 205 Broadway, Cambridge, Mass. It covers the tachometers manufactured by this Company for use on outboard motors.

Water Meters

Catalog No. W-42 issued by the Republic Flow Meters Company, 2240 Diversey Parkway, Chicago, Ill., covers the design and operation of their water meters as well as their water level and pressure meters. Typical installations are illustrated.

Water Works Journal

The June issue of the Water Works Journal, published by the Pittsburgh Equitable Meter Co., 400 Lexington Ave., Pittsburgh, Pa., contains the following articles: The Purification of Water; Private or Public Ownership of Water Systems; Water Metering an Economic Necessity; An Important Case Before the Public; A Plea for Better Treatment by "Most-any-water-Meter."

Wattmeter

Bulletin No. 428 issued by the Esterline-Angus Company, Indianapolis, Ind., describes their Three Phase, Four Wire Graphic Wattmeter.

Venturi Meters

The Builders Iron Foundry, Providence, R. I., have issued the two following bulletins: No. 206—The Venturi Meter for Low Heads and No. 143—The Construction of the Venturi Meter Tube.

"Years of Built-In Service"

Is the title of a leaflet issued by Bausch & Lomb Optical Company, Rochester, N. Y., on their new FFS-A Model Microscope.

Aircraft Instruments

Bulletin Aero 83 issued by the Askania-Werke A. G., Kaiserallee 87, Berlin-Friedenau, Germany, covers their complete line of aircraft instruments. This is printed in German.

Alcumite

The Duriron Company, Inc., Dayton, Ohio, have recently issued a leaflet on Alcumite, a copper base alloy containing an appreciable percentage of aluminum. This leaflet takes up the following points: Resistance to Corrosion; Physical properties; Annealing; Design; Forging; Cold Working; Alcumite Sheet; Applications; and Products.

Bakelite

A recent direct mailing of the Bakelite Corporation, 247 Park Ave., New York, N. Y., is entitled "On Time and Right."

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Comparator Screw Measuring Instruments

The Askania-Werke A. G., Kaiserallee 87, Berlin-Friedenau, Germany, have issued a bulletin entitled "Komparatoren Schrauben-Messapparate." The bulletin contains an illustration of the comparator built for the Potsdam Geodetic Institute.

Boiler Control—Automatic

The importance of automatic control and the basis of automatic combustion control are taken up in Druckschrift B181 published by the Askania-Werke A. G., Kaiserallee 87, Berlin-Friedenau, Germany. Their boiler control is described and illustrated in this bulletin. This literature is printed in German.

Colorimeter

The Askania Colorimeter is the subject of Catalogue Phyo 14 issued by the Askania-Werke A. G., Kaiserallee 87, Berlin-Friedenau, Germany. This literature is printed in German.

Draft Regulator

The Askania Draft Regulator is described and illustrated in their Druckschrift B158, issued by the Askania-Werke A. G., Kaiserallee 87, Berlin-Friedenau, Germany. The bulletin is in German.

Differential Pressure Recorder

Druckschrift B326 of the Askania-Werke A. G., Kaiserallee 87, Berlin-Friedenau, Germany, briefly describes their differential pressure recorder. This literature is printed in German.

Experimenter

The July issue of the Experimenter, issued by The General Radio Company, Cambridge, Mass., contained the following articles: A Direct to Consumer Policy. New Transformers. A New Amateur Wavemeter. Price Changes Effective July 1, 1928.

Economical Operation by Controllers

Druckschrift: Baro 150, issued by the Askania-Werke A. G., Kaiserallee 7, Berlin-Friedenau, Germany, covers briefly the various controllers manufactured by them. This is printed in German.

Gas and Air Meters

"Askania-Instrumente fuer Gas und Luftmessung," is the title of Druckschrift B300, recently issued by Askania-Werke A. G., Kaiseralle 87, Berlin-Friedenau, Germany.

Gas Pressure Recorder

Druckschrift B320, published recently by the Askania-Werke A. G., Kaiserallee 7, Berlin-Friedenau, Germany, briefly covers their gas pressure recorder. This is printed in German.

Glass Strain Finder

The various models of glass strain testers manufactured by the Askania-Werke A. G., Kaiserallee 87, Berlin-Friedenau, Germany, are covered in their recent Bulletin Phyo 28. This is printed in German.

Polarization Instruments

Recent literature issued by the Askania-Werke A. G., Kaiserallee 87, Berlin-Friedenau, Germany, are Phyo 26 "Halbschatten-Polarisationsapparate mit Quarzkeelkompensation" and Phyo 27 "Halbschatten-Polarisationapparate mit Kreisteilung."

High Pressure Regulator

The Askania High Pressure Regulator is covered by Druckschrift B182, recently issued by the Askania-Werke A. G., Kaiserallee 7, Berlin-Friedenau, Germany. This is printed in German.

Meteorological Instruments

Instruments for meteorology are taken up in Bulletin Geo 81, recently issued by the Askania-Werke A. G., Kaiserallee 87, Berlin-Friedenau, Germany. This is printed in German.

Microphotometer

Catalogue Astro 80 describes and illustrates the microphotometer manufactured by the Askania-Werke A. G., Kaiserallee 87, Berlin-Friedenau, Germany. This catalogue is printed in German.

Nautical Instruments for Yachts

is the title of Bulletin Nautik 84, recently issued by the Askania-Werke A. G., Kaiserallee 87, Berlin-Friedenau, Germany. This bulletin is printed in German.

Oscillography

is the title of a recent bulletin issued by the Westinghouse Electric & Manufacturing Co., East Pittsburgh, Pa. The subjects covered are: The Oscillograph in the Central Station; Industrial Applications of the Oscillograph; Westinghouse Oscillograph Apparatus.

Portable Pressure and Draft Indicator

Druckschrift B301 of the Askania-Werke A. G., Kaiserallee 87, Berlin-Friedenau, Germany covers a new portable pressure and draft indicator. This is printed in German.

Polar Coordinatograph

A new polar coordinatograph is described and illustrated in Sonderdruck Dd 333 issued by A. Ott, Kempten-Allgaeu, Germany. This is printed in German.

Planimeters and Pantographs

The planimeters and pantographs manufactured by A. Ott, Kempten-Allgaeu, Germany, are taken up in "Tarifs 303 et 403." This bulletin is printed in French.

Pressure Regulator

Druckschrift B159 describes and illustrates the pressure regulator manufactured by the Askania-Werke A. G., Kaiserallee 87, Berlin-Friedenau, Germany. This is printed in German.

Stream Gauging Instruments

The Ott stream gauging instruments manufactured by A. Ott., Kempten-Allgaeu, Germany are described and illustrated in Liste 101. This is printed in German.

Stream Gauging Instruments

The same as directly above, printed in Russian is available as Catalog 105.

Stiffness Tester

The new Askania Stiffness tester for the testing of papers, thin cardboard, foil and membranes is covered in Bulletin Phyo 19 issued by Askania-Werke A. G., Kaiserallee 87, Berlin-Friedenau, Germany. This is printed in German.

Steam Meter

New Bulletin Druckschrift B135 covers the Steam Meter manufactured by the Askania-Werke A. G., Kaiserallee 87, Berlin-Friedenau, Germany. The bulletin is printed in German.

System Load Recorder

Circular 7200-G 40-328 issued by Leeds & Northrup Company, 4901 Stenton Ave., Philadelphia, Pa., covers briefly their System Load Recorder.

Spectrometer

Druckschrift Phyo 15 issued by the Askania-Werke A. G., Kaiserallee 87, Berlin-Friedenau, Germany, covers the Spectrometer manufactured by them.

Transformers

The Dongan Electric Manufacturing Co., 2987 Franklin Street, Detroit, Michigan, have issued literature on Transformers.

Water Column Minimeter

A new water column minimeter manufactured by the Askania-Werke A. G., Kaiserallee 87, Berlin-Friedenau, Germany, is covered by Druckschrift B145. This is printed in German.

Water Measurement with Band Chronograph

A. Ott, Kempten-Allgaeu, Germany, have issued Sonderdruck Dd 334 entitled "Wassermengebestimmung mit Bandchronograph im Kraftwerk Faal A. D. Drau."

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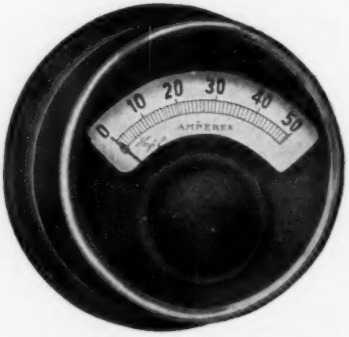

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Current Literature Review

Abstracts on instruments of interest to instrument readers

When and When Not to Make High Potential Tests. M. L. Rea. Power, April 3, 1928, pp. 600-602.

This article discusses this question and gives opinion based on many years of experience with a large number of electrical equipment installations.

Internal Focusing Anallatic Tacheometer. Engineering. March 23, 1928, p. 350.

Description of the instrument.—M. E. B.

Synchronous Motor-Driven Averaging Recorder for Power Supply. Engineering March 30, 1928, p. 392.

A description.—M. E. B.

Vibrations in Street Railway Service. P. Kremer. Engg. Progress, April 1928, pp. 107-109.

Seismographic measurements of the vibration of the ground caused by different types of street cars. Shocks transmitted to motor with different methods of motor suspension.

A Handy Hardness Tester. Engg. Progress. April 1928, pp. 117-118.

The Duroscope is described.

Gas Measuring Devices. T. H. Kerr. Gas Age-Record. May 19, 1928, pp. 699-700.

Article reprinted from Hail Columbia, organ of Columbia Engineering & Management Corp

Spectrographic Analysis. Earle E. Schumacher, Bell. Labs. Rec., May 1928, pp. 289-292.

The use of the spectrograph is briefly given.—M.B.R.

Effect of End Condition of Test Cylinder. Concrete Highways, May 1928, pp. 98.

The effect of the end condition of concrete test cylinders is given.—M.B.R.

A Modern Photographic Electrograph. R. E. Watson, Jl. Scient. Instr., May 1928, pp. 145-152.

The article describes a new installation for obtaining continuous photographic records of atmospheric electrical potential, in which, owing to the unique construction of the insulators, uncertainties due to defective insulation are reduced to a negligible amount.—M.B.R.

On the "Mistuning" of Weighted Forks. W. R. Miles, Jl. Scient. Instr., May 1928, pp. 152-154.

Weighted tuning forks in general use are so constructed that the weights cannot be adjusted with very great exactness. The question is raised whether an important error is apt to result. Photographic records are submitted which show the vibrations of both prongs when the weights have been unequally set. Variations between the settings of the two prongs as large as 22 v.d. were tried. The prongs always vibrate alike so far as rate is concerned. The "slower" prong appears to show the smaller amplitude. The change from unequal weighting, or unbalancing the fork, is shown conspicuously in the duration of the tone. Precise tuning may be done by shifting one weight.—M.B.R.

Laboratory Measurement of Capacity, Power Factor, Dielectric Constant, Inductance and Resistance, by Use of the Series Resistance Bridge. Claude L. Lyons, Jl. Scient. Inst., May 1928, pp. 155-160 (cont'd).

A "capacity bridge," incorporating the complete shielding of its elements, is described. The instrument, which is a modified form of Wiens' series resistance bridge, is designed for general use in the radio and electrical laboratory.

A survey is given of auxiliary equipment necessary to form an efficient laboratory "set-up" of the instrument, including such items as a cheap and efficient "source" of A.C. of fixed frequency and reasonably satisfactory wave-form. The use, and the schematic circuit of an auxiliary vacuum tube amplifier of the tuned audio-frequency type is shown, the purpose of which is to increase the overall efficiency of the apparatus and to assist in the more accurate determination of the exact balance point of the bridge.

The general operations, and formulae for the precise measurement of fixed and variable capacities are given, as well as for the determination of power factor, phase angle, dielectric constant and the ascertainment of small and large resistances and inductances.—M.B.R.

Continuous Reading of Varying Potentials by Means of Thermionic Valves. D. T. Harris, Jl. Scient. Inst., May 1928, pp. 161.

An assembly of apparatus, with steady zero reading, primarily designed for following changes in bio-electric potential differences, is described and illustrated.—M.B.R.

The Influence of Various Gases Upon Wire Vibration in a Corona Discharge Tube. J. E. Snyder and G. M. Evans, Jl. Scient. Inst., May 1928, pp. 166-167.

In an all-glass corona discharge tube of the wire-coaxial cylinder type, a wire which is still during a 60-cycle discharge in air, ammonia, oxygen, hydrogen or hydrogen-nitrogen mixture vibrates when these gases are replaced by nitrogen, carbon monoxide or methane. Vibration was prevented by sealing the wire while it was electrically heated and under tension.

Bimetal: The Temperature Sentinel. H. E. Cobb, Elect. Jl., June 1928, pp. 288-291.

The use of the bimetallic thermostat is mentioned. The action of the combination of the two metals is illustrated. The formula expressing the action in terms of the physical properties and the dimensions of the strip is developed.—M.B.R.

A New Portable Oil Testing Set. A. M. Wiggins, Elect. Jl., June 1928, pp. 301-302.

The set is briefly described.—M.B.R.

Fluid Governors for Prime Movers. Henry F. Schmidt, Elect. Jl., June 1928, pp. 303-306.

Part III Operating Mechanism. Simple Oil Governor. Simple single and double spring oil relays. Oil governor balance for impellar inlet pressure.—M.B.R.

Electrolytic Apparatus for the Determination of Copper in Insecticides and Fungicides. E. B. Holland and G. M. Gilligan. Ind. Engg., Chem., May 1928, p. 533.

A board and wiring diagram shows the essential features of this comparatively inexpensive apparatus—M.E.H.

Quinhydrone Electrode in Amyl Alcohol Solutions—For Determination of Neutralization Numbers of Petroleum Products. Harry Seltz and D. S. McKinney, Ind. Engg., Chem., May 1928, pp. 542-544.

The method is applicable to the determination of the neutralization numbers of petroleum oils and to the titration of free fatty acids. A diagram of the electrochemical cell, typical curves and other useful data and suggestions are given.—M.E.H.

A Simple Automatic Control of Vacuum. S. P. Miller and P. V. McKinney, Ind. Engg. Chem., May 1928, p. 552.

A workable modification of the Bureau of Mines valve operated by electromagnet, easily constructed.—M.E.H.

The Chemical Testing of Materials (Die Chemische Pruefung der Werkstoffe). J. Hausen, Messtechnik, May 22, 1928, pp. 119-124.

The importance of chemical analysis of materials is given. History of Metal Analysis. Chemical analysis as a means of material testing and control of operation. Sampling. Methods of metal analysis. New developments. Chemical testing of insulation materials. Corrosion testing.

The Determination of Gas Heating Value (Die Bestimmung des Gas heizwertes). Hans Loeffler, Messtechnik, May 22, 1928, pp. 124-126.

Enumeration and classification of the instruments used today for gas heat value determination. Description and explanation of the function of the explosion calorimeter of Strache-Loeffler.

The Accuracy of Length Measurements (Die Genanigkeet technischer Laengenmessungen). H. Vorlaender, Messtechnik, May 22, 1928, pp. 126-128.

The various factors affecting measurements are discussed.

The Siemens Smoke Density Meter (Die Siemens Rauchdichteanzeiger). H. Miething, Siemens Zeitschrift, April 1928, pp. 245-251.

The instrument arrangement and operation is described and illustrated.

Precision Resistances with a New Plug Block Arrangement (Praezisionswiderstaende mit neuer Stopselklotzanordnung). O. Schoene, Siemens-Zeitschrift, April 1928, pp. 260-264.

The new arrangement is described in some detail.

The Accurate Determination of Boiler Efficiency. R. L. Daugherty, Nat. Eng., June 1928, pp. 273.

The conditions which must be satisfied for an accurate test are given.

Testing the Refrigerating Plant. W. R. Woolrich, Power Pt. Engg., May 1, 1928, pp. 518-519.

Part II deals with the determination of the output of the ammonia compressor by the indicator.

Automatic Control of Stage Feedwater Heaters. John M. Drabelle, Power Pt. Engg., June 15, 1928, pp. 662-663.

Method of controlling the temperature of feedwater when extraction turbines are added to old plant using open heaters is given.

Eliminating Noise in High-Speed Gearing. I. Short, Power, May 1, 1928, pp. 761-764.

The resonator employed for determining the wave length of gear noises is illustrated and its use mentioned.

Experience with Boiler Gage Glasses. B. G. Elliott, Power, May 22, 1928, pp. 901-903.

The principal troubles reported with gage glasses are taken up.

Three Component Acceleration Meter (Dreikomponenten-Beschleunegungsmesser). F. H. Mayer, Messtechnik, May 22, 1928, pp. 115-119.

Sources of error and damping influence of path evaluating instruments. Necessity of a three component measurement in air ships. Direct measurement of pressure by means of piezoelectric crystals. Physical properties of pressure changing resistances and their evaluation for a three component measuring instrument. Description of the measuring arrangement.

Information Section

Correspondence from instrument users and others pertaining to or relative to instruments

THIS section invites correspondence from instrument users and others relative to questions pertaining to instruments.

Names and addresses of manufacturers of instruments will be furnished on special request. Inquiries pertaining to sources of supply should be addressed in writing to our Information Section. Such inquiries will be answered promptly by mail.

Inquiries regarding instrument problems will be answered by publication in this special "Information Section" of INSTRUMENTS. We feel that other besides the inquirers may be interested in the same or similar problems, and in this way all of our readers will obtain the benefit of the information furnished.

No. 2. Can you put us into communication with the manufacturers of the Howard-Dolman Depth Measurement Instrument?—E. F. H.

No. 15. We are looking for a device to indicate and possibly record low pressure differences. The values range from zero to 25 millimeters of water and we desire to read the pressures to one tenth millimeter fairly accurately.—A. A. G.

No. 21. I am interested in an automatic graduating machine that will cut slide rule graduations in bakelite.—W.J.H.

No. 22. Where can we get manufactured for us a small dipping needle (compass construction) but with a double center needle bearing, to operate in a vertical position?—H.W.C.

No. 23. Is there a manometer or other instrument which will indicate the flow of water in a tube one-eighth inch in inside diameter when such flow is from 15 to 600 cubic centimeter per minute?—R.S.G.

No. 24. Can you furnish me with the names of firms manufacturing transmission dynamometers of the following specifications?

Meter to be mounted on 7-7/8″ diameter shafting which rotates at a constant speed of approximately 82 R.P.M. and to measure a very unsteady load averaging about 150 H.P. but with momentary peaks of 2½ times this value meter to give a graphic record of the load or preferably an entegrated value of the load in horsepower hours or kilawatt hours.—R.S.F.

No. 25. Send name of manufacturer of a sensitive cooling water controller to function similar to the thermostat in an automobile radiator, but sensitive to ± 1° F. or closer.—H.L.P.

No. 26. Kindly send me the names of manufacturers of intermittent time indicators.—H.E.H.

Surge Tests on Isolated Neutral Network. R. Rader & V. B. Wilfley. El. World, June 16, 1928, pp. 1281-1284.

Klydonographs showed 26% of surges on 55 Kv. system to be above three times normal voltage.

Many Specially Designed Instruments are Employed in Automotive Laboratories. A. Denham, Auto. Ind., June 23, 1928, pp. 980-985.

A number of new special instruments and special applications of old instruments in developmental research work as used by the automobile companies are described and illustrated.—M.B.R.

The Hall High-Speed Recorder. Chester I. Hall, G. E. Rev., June 1928, pp. 328-331.

The instrument is described and illustrated. Uses mentioned.—M.B.R.

Recording and Controlling Instruments in the Iron and Steel Industry. C. C. Eagle and Roy M. Walker, Ir. St. Engr., June 1928, pp. 263-277.

Preprint of a paper to be given before the Annual Convention of the A. I. & S. E. E. It covers the use and value of recording and controlling instruments in the Iron and Steel Industry. —M.B.R.

Electrical Measuring Instruments other than Integrating Meters. C. V. Drysdale, Jl. Inst. Elect. Engrs., June 1928, pp. 596-616.

Electromagnetic ammeters and voltmeters. Induction Instruments. Thermal Instruments. Electrostatic Instruments. Phase or power factor indicators. Frequency meters. Leakage Indicators. Portable insulation-resistance and conductor-resistance testing sets. Electrical thermometers and pyromteers. Recording or graphic instruments. CO_2 Recorders. Electrical Gas Meters. Water testing apparatus. Moving coil galvanometers. Moving magnet galvanometers. String galvanometers. Vibration galvanometers. High frequency galvanometers and oscillographs. Magnification of galvanometer deflections. Electrometers. Resistance boxes, Wheatstone bridges and potentiometers. Magnetic testing apparatus. Thermopiles. Radio-frequency apparatus. Inductances. X-ray spectrographs. Standards and standard instruments. Distant indication and control.—M.B.R.

A Method of Measuring the Ratio and Phase Angle of a Current Transformer. W. I. Place, Jl. Inst. Elect. Engrs., June 1928, pp. 657-662.

The method introduced in 1923 by E. Biffi is discussed. Formulae are obtained for ratio and phase angle and for the galvanometer current. Biffi's formula for the ratio of current transformation is made more precise by the introduction of a term which takes account of the effect of the condenser current upon the ratio. The application of the method to comparative tests is dealt with.—M.B.R.

Modern Developments in Aircraft Instruments. C. J. Stewart, Jl. Royal Aero. Soc., June 1928, pp. 425-481.

Types of Instruments. Altimeters. Improvements in construction. Typical Temperature Errors. Errors due to Cockpit pressure. Air speed indicators. Portable air speed indicator. Statoscopes. Climb Meters. Hot wire rate of descent meter. Inclinometers. Turn indicators. Thermometers. Pressure gauges. Revolution counters. Fuel flow meter. Fuel contents gauges. Compasses. Periscopic drift sight.

The Measurement of Riding-Qualities. Roy W. Brown, Jl. S. A. E.

An accelerometer of the contact type, that employs a new means of suspending the weight, has been developed which is said to eliminate all the contact error and trouble previously experienced with this type of instrument. A counter of sufficient speed to count accurately the accelerations which occur in road service has been developed also, and a complete instrument comprising six elements has been constructed and described.

Operating Equipment at Low Cost. Mfg. Ind., June 1928, pp. 129-132.

Importance of maintaining correct speeds on manufacturing equipment by instrument control is taken up.

Precision Measuring Device (Feinmessgeraet). J. Oelschlayer, Werkst, Techn., May 1, 1928, pp. 267-268.

A new precision measuring device is described, which permits the enlargement of changes in length 200,000 times.

Testing Methods and Measuring Devices for Compressed Air Machines (Pruefmethoden und Messvorrichtungen fuer Pressluftmaschinen). E. Pallas, Zs. Oest. Ing., May 11, 1928, pp. 162-166.

The importance of checking the energy used in operations used compressed air is mentioned. Testing methods and measuring devices are taken up.

The Determination of Carbon Monoxide in Mines with the "Iodine Pentoxide" Detector. Coll. Guard., May 18, 1928, pp. 1944.

Abridgement of a paper issued by United States Bureau of Mines describing the iodine pentoxide hoolamite detector.—L.L.B.

An Electromagnetic Survey in the Ducktown District. Theodor Zuschlag and W. Kock, Engg. Min. Jl., June 2, 1928, pp. 890-892.

Strike and dip curves afford valuable data. Location, strength of mineralization and dip of oreshoots. Defining a fault.

Compression Test as a Measure of Concrete Quality. Concrete Highways, June 1928, pp. 122.

Relation between compressive strength of concrete and other properties briefly discussed and illustrated.

Scientific Instruments in Industrial Research. J. W. Williamson, Instrument World, May 1928, pp. 5-6, 9.

General discussion.

Review of Recent Patents

Printed copies may be obtained at the cost of 10 cents by addressing the Commissioner of Patents, Washington, D. C.

PSYCHROMETER. Emil J. Carroll and George W. Johnson, Cincinnati, assignors to American Laundry Machinery Co. Pat. No. 1,671,103.

FLOW METER. Harmon F. Fisher, New York, N. Y., assignor to Cochran Corporation. Pat. No. 7,671,106.

CALIPER GAUGE. Adolf Steinle, Jena, Germany, Assignor to Carl Zeiss. Pat. No. 1,671,168.

PRECISION INDICATOR FOR GAUGE MEASURING. Max Bartholdy, Essen, Germany, assignor to Fred Krupp. Pat. No. 1,671,220.

INDICATING DEVICE. Fremont H. Buckingham, Detroit, Mich., assignor to Toledo Scale Co. Pat. No. 1,671,272.

INDICATING DEVICE. Aubrey Houston, Christschurch, New Zealand, assignor to Toledo Scale Co. Pat. No. 1,671,290.

ELECTRICAL INSTRUMENT. Moses Jacobson, Camden, N. J. Pat. No. 1,671,473.

AUTOMATIC TEMPERATURE REGULATOR. Jean V. Giesler, Knoxville, Tenn., assignor to The Fulton Sylphon Co. Pat. No. 1,671,525.

MEASURING INSTRUMENT. George B. Gallasch, Rochester, N. Y., assignor to Bausch & Lomb Optical Co. Pat. No. 1,671,709.

MEASURING APPARATUS. James G. Norton, New York, N. Y. Pat. No. 1,671,737.

TESTING DEVICE. Glen W. Price, Bayonne, N. J., assignor to American Radiator Co. Pat. No. 1,671,935.

THERMOSTATIC CONTROL FOR SPEEDOMETERS. Joseph Zubatt, Flint, Mich., assignor to A. C. Spark Plug Co. Pat. No. 1,672,189.

THERMOSTATIC CONTROL SPEEDOMETERS. Joseph Zubatt, Flint, Mich., assignor to A. C. Spark Plug Co. Pat. No. 1,672,189.

INDICATING INSTRUMENT. James Walsh, Swampscott, Mass., assignor to General Electric Co. Pat. No. 1,672,666.

PHOTO-ELECTRIC PHOTOMETER. Charles J. Young, Schenectady, N. Y., assignor to General Electric Co. Pat. No. 1,672,671.

PHOTO-ELECTRIC PHOTOMETER. Charles J. Young, Schenectady, N. Y., assignor to General Electric Co. Pat. No. 1,672,672.

CALCULATING MACHINE. Charles H. Dudley, Swampscott, Mass., assignor to Krippendorf Kalculator Co. Pat. No. 1,672,882.

SEISMO VIBROMETER. Karl Ludwig Kithill, Denver, Colo. Pat. No. 1,672,892.

OSCILLOGRAPH. Joseph W. Legg, Wilkinsburg, Pa., assignor to Westinghouse Electric & Mfg. Co. Pat. No. 1,672,894.

FLOW INDICATOR. Charles D. Fagan, Sharon, Pa., assignor to Sharpsville Boiler Works Co. Pat. No. 1,673,000.

SOUND MEASURING. David G. Blattner, Bogota, N. J., assignor to Bell Telephone Laboratories. Pat. No. 1,673,037.

THERMOSTAT. Hubert R. Loranger, Hillsdale, Mich. and Dallas D. Parshall. Pat. No. 1,673,255.

SPEED INDICATOR. Maurice Reswick, Ellwood City, Pa. Pat. No. 1,673,423.

GAUGE. Warren Ames, Waltham, Mass., assignor to B. C. Ames Co. Pat. No. 1,673,480.

METERING SYSTEM. Raymond T. Pierce, East Pittsburgh, Pa., assignor to Westinghouse Electric & Mfg. Co. Pat. No. 1,673,588.

FLOW METER. Milton A. Goetz, Brooklyn, N. Y., assignor to Bailey Meter Co., Pat. No. 1,673,674.

MECHANICAL MEANS FOR USE IN FINDING GEOGRAPHICAL POSITION IN NAVIGATION. George W. Littlehales, Washington, D. C. Pat. No. 1,673,836.

THERMOSTATIC CONTROL FOR WATERHEATERS. Lee S. Chadwick, Shaker Heights Village, and Marc Reseck, E. Cleveland, Ohio, assignors to Perfection Stove Co. Pat. No. 1,673,900.

VIBROSCOPE. Thomas C. Rathborn, Ridley Park, Pa., assignor to Westinghouse Electric & Mfg. Co. Pat. No. 1,673,949.

THERMOSTATIC ELECTRIC SWITCH. John W. Anderson, Hamilton, Ontario, Canada. Pat. No. 1,674,154.

TIME-MEASURING DEVICE. Progor De Bogory, Miami, Fla.; Alexander De Bogory administrator of said Progor De Borgory, deceased, Pat. No. 1,674,161.

CALCULATING MACHINE. Carl M. F. Friden, Oakland, Calif. Pat. No. 1,674,170.

THERMOSTATICALLY - ACTUATED VALVE. John J. Kenney, Pittsburgh, Pa. Pat. No. 1,674,473.

ELECTRIC MEASURING INSTRUMENT. Theodore A. Rich, East Lynn, Mass., assignor to General Electric Co. Pat. No. 1,674,482.

ELECTRICAL INDICATING INSTRUMENT. William C. McCoy, Cleveland, Ohio, assignor to The Cleveland Trust Co. Pat. No. 1,674,688.

SPEEDOMETER. Charles H. Gill, Chicago, Ill. Pat. No. 1,674,776.

INDICATOR & RECORDER. Hugh W. Payne, Toronto, Ontario, Canada, assignor to Taylor Instrument Companies. Pat. No. 1,674,792.

THERMOSTATIC-CONTROL DEVICE FOR HEATING SYSTEMS. James Ross, East Cleveland, O. Pat. No. 1,674,800.

MECHANISM FOR MEASURING BATCHES OF MATERIAL. Leroy S Pfouts, Canton, Ohio, assignor to The H. H. Miller Industries Co. Pat. No. 1,674,991.

Several New Constructions of Meteorlogical Instruments (Einige Neukonstruktionen Meteorologischer Instrumente). Olaf Devik, Zs. Instrumenk, May 1928, pp. 218-228.

Instruments for the simultaneous recording of direction and velocity of wind.

On the Axis System for the Ballon Theodolite Suggested by Mr. Tetens (Ueber das von Herrn Tetens Vorgeschlagene Achsensystem fuer Ballon-Theodolite). Herbert Fuss, Zs. Instrumentenk, May 1928, pp. 228-234.

This instrument is used for Pilot ballon measurements, and is described here.

Installation of Heat Efficiency Control in Boiler Plants. (Aufbau Waermetechnischer Ueberwachungsanlagen in Dampfbetrieben). A. Grunwald, Siemens Zeits., March 1928, pp. 194-204.

The importance of heat efficiency control is pointed out. The instruments required for the various parts of the power plant are taken up.—Ha.

Flow Meters with Alarm. (Stroemungsmesser mit Alarmgeber). H. Lohmann, Siemens Zeits., March 1928, pp. 205-208.

In many processes where cooling liquids flow through pipes, it is important to watch this to see that the flow is not discontinued. A flow meter with an alarm is described.—Ha.

Improvements in Field of Relays. (Neuerungen auf dem Relaisgebiet). Dr. J. Sorge, Seimens Zeits, March 1928, pp. 211-220.

Improvements on the various Siemens and Halske relays are described.—Ha.

The Development of the Oscillating Direct Current Meter (Die Entwicklung des oszillierenden Gleichstrom-Zaehlers). D. Broido, A. E. G. Mitt., May 1928, pp. 189-194.

The attainable accuracy varies with the individual systems of direct current meters. The shortcomings of the oldest oscillating meters were overcome 25 years ago by the special switching of the A.E.G. as practice has shown that meters of previously unachieved accuracy and almost unlimited life were produced. In addition to the well known instruments, lately high current counters were built on the oscillating principle, with which neither separate auxiliary resistance or several current spools are required.

Geophysical Prospecting. A. S. Eve and D. A. Keys, Scientific American, June 1928, pp. 508-511, 561.

Continuation of the reprinting of Bureau of Mines Tech. Paper 420 started in the May issue. —M.B.R.

Spark and Arc Formation with Contact Thermometers (Funken und Lichbogenbildung bei Kontaktthermometer). G. Ohot, Gl. Appar., April 22, 1928, pp. 77-79.

The spark and arc formation with contact thermometers is discussed.

Is the Melting Zone of an Open Hearth Furnace a Black Body for Optical Temperature Measurements? (Ist der Herdraum eines Siemens-Martin-Ofens fuer die optische Temperaturmessung ein Schwarzer Koerper.) Herman Schmidt and W. Liesegang, Archiv fuer das Eisenhuettenwesen, May 1928, pp. 677-685.

The radiometric temperature measurements of open hearth furnaces to-date. The absorption property of freely radiating silica bricks; the measurements on the furnace; log measurements of eight heats; rapid increase of the furnace absorbing property at the beginning of the melt to about 0.9 for red light. Melting zone highest temperatures from 1700-1730°C.

Measurements of the Heat Expansion of Refractory Materials up to 1600°C. (Ueber Messungen der Waermeausdehnung feuerfester Baustoff bis 1600°C.) K. Endell and W. Steger, Archiv fuer das Eisenhuettenwessen, May 1928, pp. 721-724.

Discription of the measuring arrangement. Criticism of earlier methods. Heat expansion curves of various dolomite, magnesite and silica bricks up to 1600°C.

Scale Testing by Length Measurement. (Skalenpruefung durch Laengenmessung.) Zs. Feinmechanik, May 12, 1928, pp. 1-4.

This is an extract of information taken from Zingler's Book "Theorie der zusammengesetzten Wagen." It discusses the instrument arrangements for testing the scale of beam-scales.

The Newer Meteorological Measuring Instruments and Methods. (Ueber neuere Meteorologische Messgeraete und Methoden.) Dr. Koelzer, Zs. Feinmechanik, May 12, 1928, pp. 6-8.

Newer meteorological instruments developed as a result of the war are mentioned.

Improvements on Nonien-Theodolites. (Neuerungen an Nonien-Theodoliten.) Adolf Fennel, Zs. Vermess.

The improvements of the latest Fennel Theodolite are described.

Treatment and Testing of Aberrations by Wave Methods. C. V. Drysdale, Phot. Jl., March 1928, pp. 106-117.

In the Twenty-eighth Traill-Taylor Memorial Lecture, lens testing with the interferometer is explained by a complete treatment from first principals. Using the dioptric notation, formulas are deduced for refraction at plane and spherical surfaces. Single and compound lenses together with their various aberrations are considered.

—Abs. Bull. Kodak Res. Labs.

CANADIAN PATENTS

PAPER FINISH TESTER. Charles H. le P. Jones, Sault Ste. Marie, Ontario, Canada. Pat. No. 280,464.

ANGLE INDICATOR. Wallace Rupert Turnbull, New Brunswick, Canada. Pat. No. 280,497.

MEASURING INSTRUMENT. Benjamin H. Smith, Swissvale, Pa., assignor to The Canadian Westinghouse Co. Pat. No. 280,737.

THERMOSTAT. Hubert R. Loranger, Detroit, Mich., and Dallas D. Parshall, Watervliet, N. Y. Pat. No. 280,824.

THERMOSTAT. Hubert R. Loranger, Hilladale, Mich., and Dallas D. Parshall, Watervliet, N. Y. Pat. No. 280,825.

CAN TESTING MACHINE. James H. O'Neil and George Flook, Syracuse, N. Y., assignors to Consolidated Can Co. Pat. No. 281,289.

GASOMETER. Konrad Jagschitz, Mainz, Germany, assignor to Maschinefabrik Augsburg-Nurnberg A. G. Pat. No. 281-310.

ENGLISH PATENTS

GAS METERS ETC. A. E. White, 88 Chancery Lane, London, England, (Roots Co., Connersville, Ind.) Pat. No. 286,-142.

VERNIERS. M. A. Borel, 14 Faubaurg, St. Etienne, Pontarlier, France. (Assignee of E. Challet, 10 Rue Pradier, Geneva, Switzerland.) Pat. No. 286,-154.

SPEEDOMETERS. A. Schmelcher, Pfafferstrasse, Kiel, Germany. Pat. No. 286,-225.

COUNTING APPARATUS. A. C. Spark Plug Co., Flint, Mich. Pat. No. 286,-236.

MAGNETIC COMPASSES. Pioneer Instrument Co. Inc., 754 Lexington Ave., Brooklyn, N. Y. Pat. No. 286,277.

ELECTRIC MEASUREMENTS. Siemens & Halske A. G. Siemensstadt, Berlin, Pat. No. 286,308.

COURSE RECORDING APPARATUS. S. G. Brown, Western Ave., North Acton, Middlesex, England. Pat. No. 286,382.

THERMOMETERS. J. Casartelli, 1 Duke St., Liverpool, England. Pat. No. 286,-425.

LIQUID-LEVEL INDICATING MECHANISM. W. B. Damsel, 16 East Broad St., Columbus, Ohio. Pat. No. 286,-450.

WEIGHING APPARATUS. E. C. Marks, 57 Lincoln's Inn Fields, London, England. (Toledo Scale Co., Toledo, Ohio.) Pat. No. 286,453.

ELECTRICAL MEASUREMENTS. A. G. S. Sandison, Kelda, Baltasound, Shetland and Electroflo Meters Co., Ltd., Abbey Road, Park Royal, London, England. Pat. No. 286,468.

INDICATING ELECTRICALLY AT A DISTANCE; FLUID FLOW METERS. A. G. S. Sandison, Kelda, Baltasound, Shetland and Electroflo Meters Co., Ltd., Abbey Road, Park Royal, London, England. Pat. No. 286,469.

SETTING GAUGES FOR THE ROLLERS OF SPINNING FRAMES. Cook & Co., Manchester, Ltd., 18 Exchange St., Manchester, and H. J. Towlson, Skerrymore, Hill Top Road, Hale Cheshire, England. Pat. No. 287,002.

TESTING STRENGTH OF UNDERGROUND STRATA. A. Wolfsholz, Via Aguggiari, Varese, Italy Pat. No. 286,480.

ELECTRIC METERS. Metropolitan-Vickers Electrical Co., 4 Central Buildings, Westminster, England (Westinghouse Elect. & Mfg. Co., East Pittsburgh, Pa.) Pat. No. 286,517.

LEVELS. T. Kurita, 242 Tsunohoza, Yodobashimashi, Toyotama-gori, Tokio, Japan. Pat. No. 286,524.

ROTARY FLUID METERS. H. Youngblood, 2821 West 11 Street, Los Angeles, Calif. Pat. No. 286,540.

WEIGHING APPARATUS. Maalschappij Tot Vervaadiging van Snijmachines Volgens van Berkel's Patent en van andere werktuigen, Rotterdam, Holland. Pat. No. 286,585.

SPEEDOMETERS. A. C. Spark Plug Co., Flint, Mich. Pat. No. 286,594.

ELECTRIC METERS, ETC. Allegemeine Elektricitaets Ges. 2 Friederich Kal-Ufer, Berlin, Germany. Pat. No. 286,628.

REGULATORS. Smoot Engineering Corp., 136 Liberty St., New York, N. Y. Pat. No. 286,640.

ELECTRIC METERS. British Thomson-Houston Co., Ltd., Crown House, Aldwych, London, England. Pat. No. 286,647.

SPHYGMOMANOMETERS, ETC. W. A. Baum Co., Inc., 100 Fifth Ave., New York, N. Y. Pat. No. 286,695.

SPEEDOMETERS. G. Mombur, 16 Rue de Montbauron, Versailles, France. Pat. No. 286,737.

REGULATING APPARATUS. J. H. Reineke, 26 Castroperstrasse, Bochum, Germany. Pat. No. 286,742.

REFRACTOMETERS. W. Everett, Stanhoe, Leeds, Road, Ilkley, Yorkshire, England. Pat. No. 286,753.

DELIVERING MEASURED QUANTITIES OF LIQUID. Shell-Mex, Ltd., St. Helen's Court, Gt. St. Helens and J. Lawson, 20 Upper Addison Gardens, London, England. Pat. No. 286,754.

ELECTRIC MEASUREMENTS. B. A. Churcher, 2 Grange Road, Bawdon, Cheshire and Metropolitan Vickers Electrical Co., Ltd., 4 Central Bldgs., Westminster, London, England. Pat. No. 286,775.

INDICATING LIQUID LEVEL. C. L. Breeden, 44 Billesley Lane, Moseley, Birmingham, England. Pat. No. 286,806.

THERMOSTATS; VALVES. H. J. Yates, 15 Grosvenor Place, London, Hawlett & Co., 140 Hockley Hill Birmingham and J. Dolphin, The Ness, Old Station Road, Hampton-in-Arden, Warwickshire, England. Pat. No. 286,831.

SLIDING CALIPER GAUGES. M. A. Borel, 14 Faubaurg St., Etienne, Pontarlier, France. Pat. No. 286,965.

ELECTRIC TESTS. H. Lowy, 1 Ziegler-gasse, Vienna, Austria. Pat. No. 287,-053.

SPEEDOMETERS. G. Mombur, 16 Rue Montbauron, Versailles, France. Pat. No. 287,074.

CALCULATING APPARATUS. Zeiss Ikon A. G., Goerz Werk, Lichterfelde, Berlin, Germany. Pat. No. 287,080.

MEASURING AND DELIVERING LIQUIDS. Hawkins Equipment Co., Ltd., 160 Castlereagh St., Sydney, Australia. Pat. No. 287,149.

ELECTRIC CLOCKS. F. Conrad, 7712 Penn Ave., Pittsburgh, Pa. Pat. No. 287,182.

ELECTRIC METERS. S. Z. de Ferranti and Ferranti, Ltd., Hollinwood, Lancashire, England. Pat. No. 287,200.

WEIGHING APPARATUS. H. J. Buchanan Wollaston, The Pantiles, Pakefield, Lowestoft, England. Pat. No. 287,216.

COUNTING-APPARATUS; DELIVERING MEASURED QUANTITIES. Shell-Mex Ltd., and J. Lawson, St. Helen's Court, Great St. Helens, London, England. Pat. No. 287,268.

WEIGHING APPARATUS. Stothert & Pett, Ltd., Newark Fdry., Bath Somerset and C. W. Presland, Crowsnest, Dumsey Eyot, Shepperton, Surrey, England. Pat. No. 287,300.

SORTING BY WEIGHING. J. E. Pollak, 20 Holborn, London, England. Pat. No. 287,305.

VENTURI METERS. C. F. Higgins, 3 Central Buildings, Westminster, England. Pat. No. 287,316.

MEASURING AND DELIVERING LIQUIDS. C. J. Lawson, Box 246, Greenville, Miss. Pat. No. 287,354.

WEIGHING APPARATUS. Dayton Scale Co., 468 Huffman Ave., Dayton, O. (Assignees of J. W. Bryce, 160 Willard Ave., Bloomfield, N. J.) Pat. No. 287,444.

INDICATING FLUID FLOW. E. Brillie, 111 Boulevard St. Michel, Paris, France. Pat. No. 287,478.

MEASURING FLOW OF LIQUIDS. W. E. Favre, 4 Chemin de la Chevellarde, Geneva, Switzerland. Pat. No. 287,482.

TESTING PHYSICAL QUALITIES OF MATERIALS. O. Foeppl, 10 Bernerstrasse, Braunschweig and E. Pertz, Blankreuzhof, Post Dinker, Kreis-Soest, Germany. Pat. No. 287,500.

DYNAMOMETERS. Jung Fabrik fuer Praezisons Apparate A. G. 46 Hebelstrasse, Heidelberg, Germany. Pat. No. 287,518.

SCREW THREAD GAUGES. F. Krupp A. G. Essen, Germany. Pat. No. 287,519.

ELECTRIC CLOCKS. Vereinigte Bayerische Telephonwerke A. G., 15 Aenssere Prinz-Regentenstrasse, Munich, Germany. Pat. No. 287,531.

MAGNETIC COMPASSES. A. M. Morel, 13 Rue Bernoully and Soc. des Etablissements Krauss, 18, Rue de Naples, Paris, France. Pat. No. 287,536.

LIQUID METERS. Shell-Mex, Ltd. and J. Lawson, St. Helen's Court, Great St. Helens, London, England. Pat. No. 287,589.

SORTING SOLID MATERIALS. E. C. Marks, 57 Lincoln's Inn Fields, London, England. Pat. No. 287,596.

WEIGHING APPARATUS. J. Davis, 11 Eden Ave., Swansea and R. Thomas & Co., Ltd., Bush House, Aldwych, London, England. Pat. No. 287,606.

OPTICAL APPARATUS FOR THE SOLUTION OF TRIANGLES. Barr & Stroud, Ltd., and J. W. French, Caxton Street, Anniesland, Glasgow, Scotland. Pat. No. 287,608.

INDICATING SPEED. S. G. Brown, Western Ave., North Acton, Middlesex, England. Pat. No. 287,637.

GAS METERS. F. C. Wilson, 7 Light Lane, Coventry, England. Pat. No. 287,650.

ELECTRIC METERS. G. Wilkinson, 23 Otley Road, Harrogate, Yorkshire, England. Pat. No. 287,718.

THERMOMETERS. J. L. Orchard & Cambridge Instrument Co., Ltd., Chesterton Road, Cambridge, England. Pat. No. 287,810.

GERMAN PATENTS

GERAET ZUM ADDIEREN, SUBSTRAHIEREN ODER UMFORMEN VON DIAGRAMMEN. Gottlieb Coradi, Zuerich, Switzerland. Pat. No. 455,081.

STEIGUNGSLEHRE FUER AUSSENGEWINDE. F. Krupp, A. G. Essen, Ruhr, Germany. Pat. No. 455,195.

STOCKSTATIVE. C. Rieger, Reutlingen, Wuerttig, Germany. Pat. No. 455,196.

VORRICHTUNG ZUM MESSEN VON SCHWINGUNGSWEITEN. A. Bierend, Zeuthen, Tetlow, Germany. Pat. No. 454,971.

RICHTUNGS-UND KURVENANZEIGER FUER BEWEGTE KOERPER, LUFT, WASSERFAHRZEWGE. Gyrorector G. M. b. H. Berlin, Germany. Pat. No. 455,435.

INTEGRATOR ZUR SCHNELLEREN BERECHNUNG IM STRASSENBAU. P. Betsanis, Athens, Greece. Pat. No. 455,436.

ZUM ZIEHEN VON KURVEN DIENENDES ZEICHENGERAET. Ludwig Gressani, Zuerich, Switzerland. Pat. No. 455,499.

KOLBENFLUESSEGKEITSMESSER MIT SCHWINGENDEN ZYLINDERN. R. Bergmans, Weisbaden, Germany. Pat. No. 455,552.

MESSVORRICHTUNG FUER DEN BRENNSTOFFVERBRAUCH VON KRAFTFAHRZENGEN MIT EINEM IN DEM MESSGEFAESS ANGEORDNETEN SCHWIMMER. F. Sidebotham Rippingillo, Birmingham, England. Pat. No. 455,603.

MESSVORRICHTUNG FUER TIEFBRUNNEN. Siemens & Halske, Berlin-Siemenstadt, Germany.

SCHWIMMERSTROEMUNGSMESSER. O. Wagner, Berlin-Lankwitz, Germany. Pat. No. 455,655.

NEIGUNGSWAAGE MIT EINEM ODER MEHREREN ZUR ERWEITERUNG DES WAEGEBEREICHS DIENENDEN, ALS HEBEL AUSGEBILDETEN ZUSATZGEWICHTEN. Maatschappij von Berkel's Patent, Rotterdam, Holland. Pat. No. 455,573.

SELBSTTAETIGE WAAGE FUR MEHLUDGL, P. Steimel, Hennef, Sieg. Germany. Pat. No. 455,604.

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Instruments and accessories used for measurement, inspection or control in the industries and sciences.

If you are unable to find what you require in the Buying Section of Instruments—Industrial and Scientific, fill in the form on page 27 and we will obtain full particulars for you without charge. Give complete information of requirements.

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Otto Fennel Sons

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Hoyt Electrical Instrument Works
Rawson Electrical Instrument Company
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Bristol Company

ANEMOMETERS
B. K. Elliott Company
Taylor Instrument Companies

BAROMETERS
Aneroid, Mercurial, Recording
Colonial Supply Company
B. K. Elliott Company
Taylor Instrument Companies

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CARBON MONOXIDE METERS
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Barbour Stockwell Company
Bristol Company
Stroke
Adde Company
Bristol Company

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DRAFT GAUGES—see Gauges

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Tagliabue Mfg. Co., C. J.

FLOW METERS—see Meters

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Rawson Electrical Instrument Co.

FREQUENCY METERS
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Bristol Company
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Taylor Instrument Companies
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MODEL CONSTRUCTION
Peterson, C. W.
Schaerr, W. A.

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Bristol Company

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Schaerr, W. A.

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B. K. Elliott Company
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Taylor Instrument Companies

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Wilson-Maeulen Company, Inc.
Recording
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THERMOSTATS
American Radiator Company
Bristol Company
Taylor Instrument Companies

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A. S. Aloe Company
B. K. Elliott Company
Otto Fennel Sons

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Tagliabue Mfg. Co., C. J.

VOLTMETERS
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Hoyt Electrical Instrument Works
Rawson Electrical Instrument Company

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Bristol Company

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The Business Manager's Page

Each month the Business Manager will have a message on this page.

Prestige

The prestige which a publication gives to the advertisements in it cannot be measured by the application of any formula. Each advertiser must measure it by a study of his own past experience and the experience of others and by a wise exercise of his own judgment. There is no formula for weighing the prestige of publications, yet there are certain tangible factors to be used in the comparison of media.

Prestige is the result of character. A man's reputation is the world's estimate of his character, and reputation is based on habits. The same is true of a publication. The advertiser can judge its prestige by considering its habits. These habits are termed policies and they have to do with three different phases of the management of a publication.

1. The Editorial policy,
2. The Circulation policy, and
3. The Advertising policy.

THE EDITORIAL POLICY is important because it serves as a general guide to the kind of people who read the publication and the amount of influence it has upon its readers.

THE CIRCULATION POLICY is important because it indicates the actual value placed on a publication by those who read it.

THE ADVERTISING POLICY is important because of the very nature of the advertising accepted, and printed on its pages. Truthful statements about a product carried over the name of a responsible organization. The associates of one's advertisement are just as important indications of character as the associates of an individual.

All three policies, therefore, are important aids in the advertiser's task of weighing prestige.

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GEO. L. RAY.

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The card is arranged with a space for classification subject or number at the top. Suggestions as to classifications for the cards below are:

PHOTO-ELASTIC STRESS DETERMINATION
CHEMICAL APPARATUS

A SIMPLE ARRANGEMENT FOR PHOTO-ELASTIC EXPERIMENTS.

R. V. BAUD, INSTRUMENTS, Vol. 1, No. 7, pp. 305-309, 7 figs.

An optical arrangement using black glass plates for polarizer and analyzer is described. The application of this equipment for establishing the direction of the principal stresses and for obtaining information regarding stress magnitude is discussed briefly.

APPARATUS FOR WORKING WITH THE EXCLUSION OF AIR OR IN A NEUTRAL ATMOSPHERE.

P. DICKENS, Ph. D., INSTRUMENTS, Vol. 1, No. 7, pp. 311-312, 1 fig.

A vast number of chemical reactions must be performed in certain atmospheres. The author attacked the problem and constructed a very excellent apparatus. This is described in the article.

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STRENGTH-TESTS OF TELEPHONE MATERIALS.

J. R. TOWNSEND, INSTRUMENTS, Vol. 1, No. 7, pp. 313-315, 1 fig.

The importance and necessity for carrying out physical tests is pointed out. Some of the tests are briefly discussed.

GROUND TESTING.

T. B. WHITSON, INSTRUMENTS, Vol. 1, No. 7, pp. 317-326, 12 figs.

This is a reprint of a lecture given before the Meter Course at the Carnegie Institute of Technology. The article defines ground and then goes over to a discussion of the various methods used for testing grounds. The methods were taken as follows: Direct Reference Method by Voltmeter-Ammeter—by Wheatstone Bridge—by Ohmmeter; Three-Point Method by Voltmeter-Ammeter—by Wheatstone Bridge; Fall of Potential Method by Voltmeter-Ammeter—by "Megger" Ground Tester.

INDICATING AND INTEGRATING GROUND SPEED INDICATOR

PROF. ADAM HOFMANN, INSTRUMENTS, Vol. 1, No. 7, p. 327.

An instrument invented by W. C. Rogers is here briefly mentioned. This instrument will be completely described in a future issue of INSTRUMENTS.

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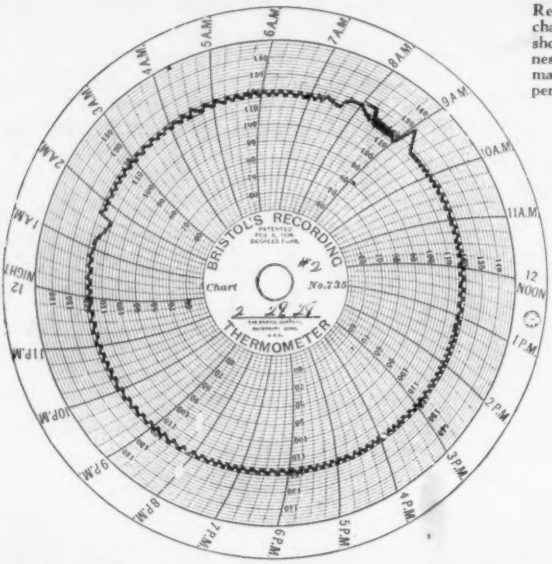

Reproduction of chart with record, showing the closeness of control maintained over a period of 24-hours.

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